Module Catalogue
for the Subject
Physics
as a Bachelor’s with 1 major
with the degree "Bachelor of Science"
(180 ECTS credits)

Examination regulations version: 2012
Responsible: Faculty of Physics and Astronomy
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Content and Objectives of the Programme
The goal of the studies is it to mediate knowledge on the most important subsections of physics and to make the students familiar with the methods of physical 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 experimental and theoretical physical terms and laws as well as on basic scientific methods and the development of the typical scientific thinking and working structures. During the Bachelor thesis the student should work on a thematic and temporally limited experimental or theoretical engineering-scientific task in the field of experimental or theoretical physics using well-known procedures and scientific criteria under guidance to a large extent independently.
Abbreviations used

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

Term: $SS = \text{summer semester}$, $WS = \text{winter semester}$

Methods of grading: $\text{NUM} = \text{numerical grade}$, $B/NB = \text{(not) successfully completed}$

Regulations: $(L)ASPO = \text{general academic and examination regulations (for teaching-degree programs)}$, $FSB = \text{subject-specific provisions}$, $SFB = \text{list of modules}$

Other: $A = \text{thesis}$, $LV = \text{course(s)}$, $PL = \text{assessment(s)}$, $TN = \text{participants}$, $VL = \text{prerequisite(s)}$

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:

$\text{ASPO2009}$

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

$\text{21-Mar-2012 (2012-37) except for mandatory electives added in Fast Track procedure at a later time}$

$\text{4-Nov-2014 (2014-69)}$

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

(123 ECTS credits)
Experimental Physics
(38 ECTS credits)
## Module Catalogue for the Subject Physics
### Bachelor’s with 1 major, 180 ECTS credits

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<td>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.</td>
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</tr>
<tr>
<td>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)</td>
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<td>2. Topics covered in lectures and exercises in part 2 (Klassische Physik 2 (Classical Physics 2)): written examination (approx. 120 minutes).</td>
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<tr>
<td>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).</td>
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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.

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### Module title
Condensed Matter (Quanta, Atoms, Molecules, Solid State Physics)

### Abbreviation
11-KM-092-m01

### Module coordinator
Managing Director of the Institute of Applied Physics

### Module offered by
Faculty of Physics and Astronomy

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### Contents

### 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

**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

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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## Module Catalogue for the Subject

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<td>Only after succ. compl. of module(s)</td>
<td>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.</td>
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### Contents

- Physical laws of Nuclear and Elementary Particle Physics
- Historical introduction
- Methods of Nuclear Physics
- Nuclear models
- Structure of nuclei
- Radioactivity and spectroscopy
- Nuclear energy
- Radiation and matter
- Accelerators and detectors
- Electromagnetic interaction
- Strong interaction
- Weak interaction
- Standard model

### Intended learning outcomes

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

### Courses

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

### Method of assessment

- written examination (approx. 120 minutes)

### Allocation of places

- 

### Additional information

- 

### Referred to in LPO I

(examination regulations for teaching-degree programmes)

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Bachelor’s with 1 major Physics (2012)  
JMU Würzburg • generated 23-Aug-2021 • exam. reg. data record Bachelor (180 ECTS) Physik - 2012  
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Theoretical Physics
(32 ECTS credits)

For students interested in participating in the FOKUS programme, module 11-TQM-F will replace module 11-TQM. Module component 11-TQM-F-2, which will prepare students for studying in the Master's programme FOKUS Physik (FOKUS Physics), 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).
### Module title
Statistical Mechanics, Thermodynamics and Electrodynamics

### Abbreviation
11-STE-092-m01

### Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

### Module offered by
Faculty of Physics and Astronomy

### ECTS
16

### Method of grading
Numerical grade

### Only after succ. compl. of module(s)
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### Duration
2 semester

### Module level
Undergraduate

### Other prerequisites
10-M1-PHY and 10-M2-PHY or 10-M1-NST and 10-M2-NST

### Contents

### Intended learning outcomes
The students have advanced knowledge of the methods of Theoretical Physics. They know the principles of electrodynamics, thermodynamics and statistical mechanics. They are familiar with the corresponding calculation methods and are able to independently apply them to the description and solution of problems in this area.

### Courses
- **Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics):** V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester)
- **Theoretische Elektrodynamik (Theoretical Electrodynamics):** V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)

### Method of assessment
This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics)): written examination (approx. 120 minutes).
2. Topics covered in lectures and exercises in part 2 (Theoretische Elektrodynamik (Theoretical Electrodynamics)): 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.

Students are highly recommended to attend both courses Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics) and Theoretische Elektrodynamik (Theoretical Electrodynamics). 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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### Referred to in LPO I
(examination regulations for teaching-degree programmes)
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Module title | Abbreviation
---|---
Theoretical Mechanics and Quantum Mechanics | 11-TQM-092-m01

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

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<th>ECTS</th>
<th>Method of grading</th>
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<td>16</td>
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</table>

Duration | Module level | Other prerequisites
2 semester | undergraduate | 10-M1-PHY, 10-M2-PHY and 11-MPI-3 or 10-M1-NST, 10-M2-NST and MPI-3

Contents

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

Courses (type, number of weekly contact hours, language — if other than German)
Theoretische Mechanik (Theoretical Mechanics): 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)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Theoretische Mechanik (Theoretical Mechanics)): written examination (approx. 120 minutes).
2. Topics covered in lectures and exercises in part 2 (Quantenmechanik (Quantum Mechanics)): 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).
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 Theoretische Mechanik (Theoretical Mechanics) and Quantenmechanik (Quantum Mechanics). 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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Module title | Abbreviation
---|---
Theoretical Mechanics and Quantum Mechanics for FOKUS Students | 11-TQM-F-092-m01

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

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<tbody>
<tr>
<td>2 semester</td>
<td>undergraduate</td>
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</tr>
</tbody>
</table>

Contents


Intended learning outcomes

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

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

Theoretische Mechanik (Theoretical Mechanics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter 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 is creditable for bonus)

This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Theoretische Mechanik (Theoretical Mechanics)): written examination (approx. 120 minutes).
2. Topics covered in lectures and exercises in part 2 (Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students)): 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).

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 Theoretische Mechanik (Theoretical Mechanics) and Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students). 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

Students who intend to study the FOKUS Master’s degree programme must take Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students) instead of Quantenmechanik (Quantum Mechanics).

Referred to in LPO I (examination regulations for teaching-degree programmes)
Lab Course Physics
(21 ECTS credits)

Modules from the area Physikalisches Praktikum (Physics Practical Course) will not factor into the overall grade of the Bachelor's degree.
Module title: Lab Course A
Abbreviation: 11-P-PA-112-m01

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

ECTS: 5
Method of grading: Only after succ. compl. of module(s)
(not) successfully completed: --
Duration: 1 semester
Module level: undergraduate
Other prerequisites: --

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 is creditable for 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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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 title | Abbreviation
---|---
Laboratory Course Physics B | 11-P-PB-122-m01

<table>
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<th>Module offered by</th>
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<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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ECTS | Method of grading | Only after succ. compl. of module(s)
---|---|---
8 | (not) successfully completed | 11-P-PA

<table>
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<tr>
<th>Duration</th>
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<td>1 semester</td>
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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)
Klassische Physik (Classical Physics, KLP): P (2 weekly contact hours)
Elektrizitätslehre und Schaltungen (Electricity and Circuits, ELS): 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 is creditable for bonus)
This module has the following assessment components
1. Lab course in part 1: 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).
2. Lab course in part 2: 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).

Students must register for assessment components 1 and 2 online (registration deadline to be announced). Students will be offered one opportunity to retake element a) and/or element b). To pass an assessment component, they must pass both elements a) and b).

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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Referred to in LPO I (examination regulations for teaching-degree programmes)
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Module title  
Advanced Laboratory Course Physics C  

<table>
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<tr>
<th>Abbreviation</th>
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**Module coordinator**
Managing Director of the Institute of Applied Physics  
**Module offered by**
Faculty of Physics and Astronomy  

**ECTS**  
8  

**Method of grading**  
Only after succ. compl. of module(s)  

**Duration**  
1 semester  

**Module level**  
undergraduate  

**Other prerequisites**  
11-P-PA and 11-P-PB  

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### 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

Physikalisches Praktikum (Physics Practical Course) Part C-1: P (2 weekly contact hours)  
Physikalisches Praktikum (Physics Practical Course) Part C-2: P (2 weekly contact hours)

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### Method of assessment

This module has the following assessment components

1. Lab course in part 1: 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).

2. Lab course in part 2: 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).

Students must register for assessment components 1 and 2 online (registration deadline to be announced). Students will be offered one opportunity to retake element a) and/or element b). To pass an assessment component, they must pass both elements a) and b).

To pass this module, students must pass both assessment component 1 and assessment component 2.

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### Allocation of places

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### Additional information

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

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Mathematics
(32 ECTS credits)
Module title: Mathematics 1 and 2 for students in Physics

Abbreviation: 10-M-PHY12-092-m01

Module coordinator: Dean of Studies Mathematik (Mathematics)

Module offered by: Institute of Mathematics

ECTS: 16

Method of grading: numerical grade

Duration: 2 semester

Module level: undergraduate

Other prerequisites: By way of exception, additional prerequisites are listed in the section on assessments.

Contents:
Fundamentals on numbers and functions, sequences and series, differential and integral calculus in one variable, vector spaces, simple differential equations, linear maps and systems of linear equations, matrix calculus, eigenvalue theory, differential and integral calculus in several variables, differential equations, Fourier analysis.

Intended learning outcomes:
The student gets acquainted with fundamental concepts of advanced mathematics. He/She learns to apply these methods to problems in natural sciences, in particular in physics, and is able to interpret the results.

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

- 10-M-PHY12-1-092: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-PHY12-2-092: V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment:
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-PHY12-1-092: Mathematics 1 for Students in Physics

- 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-PHY12-2-092: Mathematics 2 for Students in Physics

- 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
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.

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</table>
Module title: Mathematics 3 and 4 for Physicists and Engineers
Abbreviation: 11-DFS-092-m01

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

ECTS: 16
Method of grading: numerical grade
Only after succ. compl. of module(s): --

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

Contents:
Principles of common and partial differential equations in Physics as well as function analysis and theory. The lecture of the module component 11-DFS-1 covers common differential equations, systems of differential equations and partial differential equations. The lecture of the module component 11-DFS-2 covers basic knowledge of functional analysis, which is needed in the course Quantum mechanics I. The definition of Hilbert space explains quantum mechanical states as vectors. The non-visualised form of quantum mechanics, the depiction as wave function created through basic states and the Dirac bracket formalism make up an important part of the formal framework of quantum mechanics.

Intended learning outcomes:
The students have basic mathematical knowledge of dynamic equations and solution methods for common and partial differential equations. In addition, they have basic knowledge of the mathematics of Hilbert space and the theory of functions of complex variables and are familiar with the corresponding calculation methods.

Courses:
(Mathematics 3): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester)
(Mathematics 4): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)

Method of assessment:
This module has the following assessment components
1. Topics covered in lectures and exercises in part 1 (Mathematik 3 (Mathematics 3)): written examination (approx. 120 minutes).
2. Topics covered in lectures and exercises in part 2 (Mathematik 4 (Mathematics 4)): 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 Mathematik 3 (Mathematics 3) and Mathematik 4 (Mathematics 4). 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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Compulsory Electives
(27 ECTS credits)

Of a total of 27 ECTS credits in the area of mandatory electives, a total of 10 ECTS credits achieved in modules with numerical grading will factor into the overall grade of the Bachelor's degree.
Chemistry, Computer Science, Numerical Mathematics
(max. 27 ECTS credits)

Modules covering fundamental principles of chemistry, computer science and numerical mathematics.
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
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<td>General Chemistry for Physics and Engineers</td>
<td>08-CP1-102-m01</td>
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<tbody>
<tr>
<td>lecturer of the course</td>
<td>Institute of Inorganic Chemistry</td>
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<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

### 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

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

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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### Referred to in LPO 1 (examination regulations for teaching-degree programmes)

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Module title | Abbreviation
---|---
Introduction to Computer Science for Students of all Faculties | 10-I-EIN-072-m01

Module coordinator | Module offered by
Dean of Studies Informatik (Computer Science) | Institute of Computer Science

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<th>Other prerequisites</th>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: academic requirements to be met in exercises as specified at the beginning of the course.</td>
</tr>
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</table>

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

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

Method of assessment

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: 30 minutes, groups of 3: 40 minutes)

Allocation of places

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Additional information

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

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<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
<tr>
<td>Computer-Oriented Mathematics</td>
<td>10-M-COM-082-m01</td>
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<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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<th>Method of grading</th>
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<th>Other prerequisites</th>
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<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance of exercises (attendance monitored, a maximum of one incident of unexcused absence).</td>
</tr>
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</table>

**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 is creditable for bonus)

Project in the form of programming exercises (as specified at the beginning of the course)
Assessment offered: once a year, summer semester
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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

§ 73 (1) 5. Mathematik Angewandte Mathematik
<table>
<thead>
<tr>
<th>Module title</th>
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<td>Numerical Mathematics 1</td>
<td>10-M-NM1-082-m01</td>
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<tr>
<td>8</td>
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<td>--</td>
<td>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.</td>
</tr>
</tbody>
</table>

**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 is creditable for bonus)

written examination (approx. 90 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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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

§ 73 (1) 5. Mathematik Angewandte Mathematik
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
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<td>Numerical Mathematics 2</td>
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<td>Dean of Studies Mathematik (Mathematics)</td>
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<th>ECTS</th>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Contents**

Solution methods and applications for eigenvalue problems, linear programming, initial value problems for ordinary differential equations, boundary value problems.

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

written examination (approx. 90 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**

--

**Additional information**

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**Referred to in LPO I**

§ 73 (1) 5. Mathematik Angewandte Mathematik
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<td>Programming course for students of Mathematics and other subjects</td>
<td>10-M-PRG-082-m01</td>
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<th>Module coordinator</th>
<th>Module offered by</th>
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<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance (attendance monitored, a maximum of one incident of unexcused absence).</td>
</tr>
</tbody>
</table>

**Contents**
Basics of a modern programming language (e.g. C or Fortran) taking into account the particular needs in mathematics.

**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 is creditable for bonus)

project in the form of programming exercises (as specified at the beginning of the course)
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**
--

**Additional information**
--

**Referred to in LPO I** (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
### Module Catalogue for the Subject

**Physics**

**Bachelor’s with 1 major, 180 ECTS credits**

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Topics in Experimental Physics</td>
<td>11-BXE5-112-m01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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</thead>
<tbody>
<tr>
<td>chairperson of examination committee</td>
<td>Faculty of Physics and Astronomy</td>
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</tbody>
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<table>
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<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Current topics of Experimental Physics. Accredited academic achievements, e.g. in case of change of university or study abroad.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intended learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students have advanced competencies corresponding to the requirements of a module of Experimental Physics of the Bachelor’s programme. They have knowledge of a current subdiscipline of Experimental Physics and understand the measuring and/or evaluation methods necessary to acquire this knowledge. They are able to classify the subject-specific contexts and know the application areas.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Courses</th>
<th>Method of assessment</th>
<th>Allocation of places</th>
</tr>
</thead>
<tbody>
<tr>
<td>V + R (no information on SWS (weekly contact hours) and course language available)</td>
<td>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)</td>
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<table>
<thead>
<tr>
<th>Language of assessment: German or English</th>
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<table>
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<tr>
<th>Additional information</th>
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<table>
<thead>
<tr>
<th>Referred to in LPO I</th>
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<tbody>
<tr>
<td>(examination regulations for teaching-degree programmes)</td>
</tr>
</tbody>
</table>
Module title | Abbreviation
--- | ---
Current Topics in Experimental Physics | 11-BXE6-112-m01

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

<table>
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<tr>
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<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Approval by examination committee required.</td>
</tr>
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</table>

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

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

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

Method of assessment
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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Referred to in LPO I (examination regulations for teaching-degree programmes)
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<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
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<td>Faculty of Physics and Astronomy</td>
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<th>Duration</th>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**

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

**Intended learning outcomes**

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

**Courses**

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 is creditable for 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**

--

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

--
Module title | Abbreviation
---|---
Current Topics in Theoretical Physics | 11-BXT5-112-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 in Theoretical Physics. Credited academic achievements, e.g. in case of change of university or study abroad.

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

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

Method of assessment
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
--

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

**Current Topics in Theoretical Physics**

| Abbreviation | 11-BXT6-112-m01 |

## Module coordinator

Chairperson of examination committee

## Module offered by

Faculty of Physics and Astronomy

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
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## Contents

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

## Intended learning outcomes

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

## Courses

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

## Method of assessment

- 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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## Referred to in LPO I

(examination regulations for teaching-degree programmes)

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<table>
<thead>
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**Module coordinator**
chairperson of examination committee

**Module offered by**
Faculty of Physics and Astronomy

<table>
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<tr>
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<td>numerical grade</td>
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</table>

**Duration**
1 semester

**Module level**
undergraduate

**Other prerequisites**
Approval by examination committee required.

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

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

**Courses** (type, number of weekly contact hours, language — if other than German)
V + 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 is creditable for 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**
--

**Additional information**
--

**Referred to in LPO I** (examination regulations for teaching-degree programmes)
--
Applied Physics and Metrology
(max. 27 ECTS credits)

Modules offered by the Faculty in the area of Angewandte Physik und Messtechnik (Applied Physics and Measurement Technology).
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Electronics</td>
<td>11-A2-092-m01</td>
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<table>
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<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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<tr>
<td>6</td>
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<td>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.</td>
</tr>
</tbody>
</table>

### 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

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

### Method of assessment

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

Referred to in LPO I (examination regulations for teaching-degree programmes)
Module title: Laboratory and Measurement Technology

Abbreviation: 11-A3-072-m01

Module coordinator: Managing Director of the Institute of Applied Physics

Module offered by: Faculty of Physics and Astronomy

ECTS: 6

Method of grading: Only after succ. compl. of module(s)

Duration: 1 semester

Module level: undergraduate

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

Method of assessment:
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:

Referred to in LPO I (examination regulations for teaching-degree programmes)
Module title | Abbreviation
---|---
Reproducing Sensors in Infrared | 11-ASI-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)
---|---|---
3 | 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

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

Intended learning outcomes

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

Courses (type, number of weekly contact hours, language — if other than German)
V + 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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
## Module Catalogue for the Subject Physics

**Bachelor's with 1 major, 180 ECTS credits**

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
<tr>
<td>Applied Superconduction</td>
<td>11-ASL-092-m01</td>
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<table>
<thead>
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<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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<table>
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<th>Method of grading</th>
<th>Only after succ. compl. of module(s)</th>
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<tr>
<th>Duration</th>
<th>Module level</th>
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<tbody>
<tr>
<td>1 semester</td>
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</tr>
</tbody>
</table>

### Contents


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

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<table>
<thead>
<tr>
<th>Module title</th>
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<tbody>
<tr>
<td>Principles of Image Processing</td>
<td>11-EBV-092-m01</td>
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</table>

**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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

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<tr>
<td>Principles of Energy Technologies</td>
<td>11-ENT-092-m01</td>
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<tr>
<th>Intended learning outcomes</th>
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<tr>
<td>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.</td>
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</table>

<table>
<thead>
<tr>
<th>Courses</th>
<th>Method of assessment</th>
<th>Allocation of places</th>
<th>Additional information</th>
<th>Referred to in LPO I</th>
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<td>R + V (no information on SWS (weekly contact hours) and course language available)</td>
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Language of assessment: German, English
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<th>Module title</th>
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<tbody>
<tr>
<td>Introduction to Plasmaphysics</td>
<td>11-EPP-092-m01</td>
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**Module coordinator**
Managing Director of the Institute of Theoretical Physics and Astrophysics

**Module offered by**
Faculty of Physics and Astronomy

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|---------|--------------|------------------------------------|---------------------|
| 1 semester | graduate    |                                    |                     |

**Contents**
Plasma Astrophysics: Dynamics of charged particles in electric and magnetic fields, Magnetohydrodynamics, Transport equations for energetic particles, Properties of magnetic turbulence, Propagation of solar particles within the solar wind, Particle acceleration via shock waves and via interaction with plasma turbulence, Particle acceleration and transport in galaxies and other astrophysical objects, Cosmic radiation.

**Intended learning outcomes**
The students know the principles of Plasma Physics, especially the description of transport phenomena in plasma. They are able to solve basic problems of Plasma Physics and to apply this knowledge to Astrophysics.

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

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Module title | Abbreviation
---|---
Principles of Classification of Patterns | 11-KVM-092-m01

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

<table>
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<tr>
<td>3</td>
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<th>Duration</th>
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<tr>
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<td>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.</td>
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Contents

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

Intended learning outcomes

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

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

V + 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 is creditable for bonus)

a) written examination (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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<table>
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<th>Module title</th>
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<tr>
<td>Organic Semiconductor</td>
<td>11-OHL-092-m01</td>
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<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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<tbody>
<tr>
<td>1 semester</td>
<td>graduate</td>
<td>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.</td>
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Contents

Physical principles of organic semiconductors, molecular and polymer electronics and sensor technology, applications.

Intended learning outcomes

The students have advanced knowledge of organic semiconductors.

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

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Module title | Abbreviation
--- | ---
Thermodynamics and Economics | 11-TDOE-141-m01

Module coordinator |
Managing Director of the Institute of Theoretical Physics and Astrophysics

Module offered by |
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 is creditable for 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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<td>Astronomical Methods</td>
<td>11-ASM-131-m01</td>
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**Contents**

Methods of observational astronomy across the electromagnetic spectrum. Extraction and reduction of observational data from radio, optical, X-ray and gamma-ray telescopes.

**Intended learning outcomes**

Overview of the methods used in observational astronomy in various parts of the electromagnetic spectrum (radio, optical, X-ray and gamma-ray energies). Knowledge of principles and applications of these methods and ability to conduct astronomical observations.

**Courses**

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

**Method of assessment**

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

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## Module Catalogue for the Subject
### Physics
Bachelor's with 1 major, 180 ECTS credits

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</table>

### 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

**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 is creditable for 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
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</table>
Module title

Principles of two- and three-dimensional Röntgen imaging

Abbreviation

11-ZDR-111-m01

Module coordinator

Managing Director of the Institute of Applied Physics

Module offered by

Faculty of Physics and Astronomy

ECTS

6

Method of grading

Only after succ. compl. of module(s)

Duration

1 semester

Module level

graduate

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.

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 back 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

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

Method of assessment

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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**Contents**

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

**Intended learning outcomes**

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

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

V + 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 is creditable for 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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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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## Module Catalogue for the Subject

**Physics**

Bachelor's with 1 major, 180 ECTS credits

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**Duration**

1 semester

**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

(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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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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Module title | Abbreviation
---|---
Current Topics in Experimental Physics | 11-BXE8-112-m01

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

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

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

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

Method of assessment
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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Referred to in LPO I (examination regulations for teaching-degree programmes)
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 Bachelor's with 1 major Physics (2012)
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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

V + 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 is creditable for 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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**Contents**

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

**Intended learning outcomes**

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

**Courses**

(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 is creditable for 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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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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### Module Title and Abbreviation

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### Module Coordinator and Offered By
- **Chairperson of Examination Committee**
- **Module offered by**: Faculty of Physics and Astronomy

###ECTS, Method of Grading, and Duration
- **ECTS**: 8
- **Method of grading**: numerical grade
- **Duration**: 1 semester
- **Other prerequisites**: Approval by examination committee required.

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

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

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

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

###Allocation of Places
- **--**

###Additional Information
- **--**

###Referred to in LPO I
- **(examination regulations for teaching-degree programmes)**
- **--**
## Module title
Image and Signal Processing in Physics

## Abbreviation
11-BSV-122-m01

## Module coordinator
Managing Director of the Institute of Applied Physics

## Module offered by
Faculty of Physics and Astronomy

## ECTS
6

## Method of grading
Only after succ. compl. of module(s)

## Numerical grade
--

## Duration
1 semester

## Module level
graduate

## 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.

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

## Method of assessment
(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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## Referred to in LPO I
(examination regulations for teaching-degree programmes)

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Module title: Image and Signal Processing in Physics
Abbreviation: 11-BSV-131-m01

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

ECTS: 6
Method of grading: Only after succ. compl. of module(s)
Numerical grade: --
Duration: 1 semester
Module level: graduate

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 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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Solid State Physics and Nanostructures
(max. 27 ECTS credits)

Modules for advanced Bachelor's students offered by the Faculty with regard to preparation for Bachelor's thesis and specialisation in Master's programme.
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, barritt 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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes)
## Module title
Applied Superconduction

## Abbreviation
11-ASL-092-m01

## Module coordinator
Managing Director of the Institute of Applied Physics

## Module offered by
Faculty of Physics and Astronomy

## ECTS
6

## Method of grading
Only after succ. compl. of module(s)

## Numerical grade
--

## Duration
1 semester

## Module level
graduate

## 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.

## Contents

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

## Method of assessment
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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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Intended learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>graduate</td>
<td>The students have specific and advanced knowledge in the field of Solid-State Physics. They are theoretically able to specialise in a sub-discipline of Solid-State Physics.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Courses</th>
<th>Method of assessment</th>
<th>Allocation of places</th>
</tr>
</thead>
<tbody>
<tr>
<td>R + V (no information on SWS (weekly contact hours) and course language available)</td>
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</tr>
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<table>
<thead>
<tr>
<th>Language of assessment: German, English</th>
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<table>
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<tr>
<th>Additional information</th>
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</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Referred to in LPO I</th>
<th>(examination regulations for teaching-degree programmes)</th>
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</thead>
<tbody>
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</tbody>
</table>
### Module Catalogue for the Subject

**Physics**

**Bachelor's with 1 major, 180 ECTS credits**

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid State Spectroscopy</td>
<td>11-FKS-092-m01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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<table>
<thead>
<tr>
<th>ECTS</th>
<th>Method of grading</th>
<th>Other prerequisites</th>
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<tbody>
<tr>
<td>6</td>
<td>Only after succ. compl. of module(s)</td>
<td>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.</td>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Contents</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Intended learning outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Courses (type, number of weekly contact hours, language — if other than German)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R + V (no information on SWS (weekly contact hours) and course language available)</td>
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<thead>
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<td>Language of assessment: German, English</td>
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<thead>
<tr>
<th>Allocation of places</th>
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<tr>
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</tbody>
</table>
## Module title
Transport Phenomena in Solids

## Abbreviation
11-FKT-092-m01

## Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

## Module offered by
Faculty of Physics and Astronomy

## ECTS
6

## Method of grading
numerical grade

## Only after succ. compl. of module(s)
--

## Duration
1 semester

## Module level
graduate

## 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.

## Contents
Transport phenomena in solids.

## Intended learning outcomes
The students have specific and advanced knowledge in the field of transport phenomena in solids.

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

## Method of assessment
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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## Referred to in LPO I
(examination regulations for teaching-degree programmes)

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Module title: Semiconductor Lasers - Principles and Current Research
Abbreviation: 11-HLF-092-m01

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

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

Duration: 1 semester
Module level: graduate

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.

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 is creditable for bonus)
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Language of assessment: German, English

Allocation of places:
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Additional information:
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<thead>
<tr>
<th>Module title</th>
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<td>Semiconductor Physics</td>
<td>11-HLP-092-m01</td>
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**Contents**


**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)

<table>
<thead>
<tr>
<th>R + V</th>
<th>SWS (weekly contact hours)</th>
<th>Language available</th>
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**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

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

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

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# Module Catalogue for the Subject

**Physics**

**Bachelor's with 1 major, 180 ECTS credits**

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetism</td>
<td>11-MAG-092-m01</td>
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</table>

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<tbody>
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**Duration**

<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>graduate</td>
<td>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.</td>
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</table>

## 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

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

## Method of assessment

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

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### Module title
- **Magnetism and Spin Transport**

### Abbreviation
- 11-MST-092-m01

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
</tr>
</thead>
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### Contents
The module spans two semesters. During the winter semester, the students become acquainted with the principles of magnetism (ranging from atoms to solids), properties of magnetic material (individual usage) and methods to characterise magnetic properties. During the summer semester, the students learn about spin transport in metallic systems in due consideration of giant magnetoresistance and tunnel magnetoresistance and its application in magnetic memory. 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 terms, concepts and phenomena of magnetism and measuring methods for magnetic experiments; they are familiar with spin transport applications of information technologies and have gained an overview of modern findings in this area (GMR, TMR). 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.

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

### Method of assessment
- 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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### Referred to in LPO 1
(examination regulations for teaching-degree programmes)
--
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

<table>
<thead>
<tr>
<th>ECTS</th>
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**Contents**


**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**

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

**Method of assessment**

- 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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**Referred to in LPO I**

( examination regulations for teaching-degree programmes)

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Module title: Low-Dimensional Structures
Abbreviation: 11-NDS-092-m01

Module coordinator:
Managing Director of the Institute of Applied Physics

Module offered by:
Faculty of Physics and Astronomy

ECTS: 4
Method of grading: numerical grade
Duration: 1 semester
Module level: graduate
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.

Contents:
Low-dimensional structures: Crystal lattice symmetry. Lattice dynamics and growth techniques of low-dimensional structures. Comparison between these structures and volume solids. X-ray diffractometry. Molecular beam epitaxy.

Intended learning outcomes:
The students have knowledge of the theoretical principles of the growth of low dimensional structures. They know methods of producing and analysing such structures. They know the bandstructures of the most important semiconductors as well as the fabrication and characteristics of semiconductor heterostructures and MOS-diodes. They are familiar with the subband structure of semiconductor heterostructures and MOS-diodes and can evaluate the importance of many-particle effects. They are able to solve problems related to potentials in one dimension by applying Poisson’s equation. They know the k*p perturbation theory and can deduce the 2D subband structure from the bulk band structure. They have knowledge of the meaning of modulation doping and are familiar with the 2D hydrogen atom. They understand how an external magnetic field acts on the properties of a free electron gas in 2D. They have basic knowledge of the meaning of gauging, Landau-quantisation, filling factor and Landau degeneracy. They understand the dependence of various physical properties on the filling factor, and are able to solve implicit problems via numerical methods. They are familiar with elementary excitations in two-dimensional systems.

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:
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Language of assessment: German, English

Allocation of places:

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<td>Quantum Transport in Semiconductor Nanostructures</td>
<td>11-QTH-102-m01</td>
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</table>

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

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<td>Nano-Optics</td>
<td>11-NOP-092-m01</td>
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<tr>
<td>Managing Director of the Institute of Applied Physics</td>
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</table>

**Contents**


**Intended learning outcomes**

The students have specific and advanced knowledge in the field of nano-optics. They are familiar with the theoretical principles and application areas of nano-optics and with current developments in this field.

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

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Module title | Abbreviation
---|---
Quantum Mechanics II | 11-QM2-092-m01

Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

Module offered by
Faculty of Physics and Astronomy

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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, Lorentz 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 is creditable for 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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### Referred to in LPO I

(Examination regulations for teaching-degree programmes)

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<td>Quantum Phenomena in electron correlated Materials</td>
<td>11-QPM-092-m01</td>
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**Module coordinator**
Managing Director of the Institute of Applied Physics

**Module offered by**
Faculty of Physics and Astronomy

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**Duration**
1 semester

**Module level**
graduate

**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.

**Contents**
Quantum effects and phenomena in current solid-state research. Correlations. Free electron gas and Fermi liquid. Strongly correlated systems

**Intended learning outcomes**
The students have specific, advanced knowledge of the current research on Solid-State Physics, especially on quantum effects in strongly correlated systems. They are able to understand the connections between the theoretical description of such systems and the current experimental results.

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

**Method of assessment**
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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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
--
Many Body Quantum Theory

11-QVTP-092-m01

Managing Director of the Institute of Theoretical Physics and Astrophysics

Faculty of Physics and Astronomy

ECTS: 8

8

numerical grade

Module coordinator

Module offered by

Contents

This will usually be a course on quantum many particle physics approached by the perturbative methods using Green's functions.

An outline could be:

1 Single-particle Green's function
2 Review of second quantization
3 Diagrammatic method using many particle Green's functions at temperature T=0
4 Diagrammatic method for finite T
5 Landau theory of Fermi liquids
6 Superconductivity
7 One-dimensional systems and bosonization

Intended learning outcomes

The students have mastered the principles of quantum field theory in many-particle systems. They are able to apply the acquired methods to current problems of Theoretical Solid-State Physics.

Method of assessment

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

Additional information

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<td>Relativistic Effects in Mesoscopic Systems</td>
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**Contents**
Relativistic effects in mesoscopic systems. - Spin-orbit coupling. - Dirac equation. - Quantum Hall effect. - Topological insulators. - Majorana fermions

**Intended learning outcomes**
The students have mastered the mathematical methods for the description of relativistic quantum systems, especially in the field of mesoscopic physics. They are able to apply their knowledge to simple systems.

**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 is creditable for 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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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
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Module title | Abbreviation
--- | ---
Theoretical Solid State Physics | 11-TFK-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 | 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

Intended learning outcomes
The students have basic knowledge of the theoretical description of solid-state phenomena. They know the corresponding mathematical or theoretical methods and are able to apply them to basic problems of solid-state theory and to understand the connections to experimental results. The individual students have elaborated on an advanced topic of solid-state theory and have discussed this topic in a seminar presentation.

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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes)
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Module title: Theory of Superconduction  
Abbreviation: 11-TSL-092-m01

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

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

Duration: 1 semester  
Module level: graduate  
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.

Contents

Intended learning outcomes
The students have basic knowledge of the theoretical models for the description of superconductivity. They know the properties and application areas of these models and are able to apply calculation methods to simple problems.

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

Method of assessment
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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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
### Module title
Renormalization Group Methods in Field Theory

### Abbreviation
11-RMFT-102-m01

### Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

### Module offered by
Faculty of Physics and Astronomy

### ECTS
6

### Method of grading
numerical grade

### Only after succ. compl. of module(s)
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### Duration
1 semester

### Module level
graduate

### 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.

### Contents
Renormalisation group methods for non-linear partial differential equations, field theoretical contexts and non-analysed behaviour of cryogenic temperatures.

### Intended learning outcomes
The students gain an overview of non-linearities in partial differential equations and their solution on the basis of the renormalisation group method.

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

### Method of assessment
(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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### Referred to in LPO I
(examination regulations for teaching-degree programmes)

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Module title | Abbreviation
---|---
Spintronics | 11-SPI-102-m01

**Module coordinator**
Managing Director of the Institute of Applied Physics

**Module offered by**
Faculty of Physics and Astronomy

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**Duration**
1 semester

**Module level**
graduate

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**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 is creditable for 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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**Referred to in LPO I**
(examination regulations for teaching-degree programmes)
--
## Module title

**Introduction to Electron Microscopy**

### Abbreviation

11-IEM-111-m01

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### Module coordinator

Managing Director of the Institute of Applied Physics

### Module offered by

Faculty of Physics and Astronomy

### ECTS

4

### Method of grading

numerical grade --

### Duration

1 semester

### Module level

graduate

### 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.

### 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).

### 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

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

### Method of assessment

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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### Referred to in LPO I

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<td>chairperson of examination committee</td>
<td>Faculty of Physics and Astronomy</td>
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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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

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### Contents

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

### Intended learning outcomes

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

### Courses

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

### Method of assessment

- 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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### Referred to in LPO I

(examination regulations for teaching-degree programmes)

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<table>
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<tr>
<th><strong>Module title</strong></th>
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<tr>
<td>Current Topics in Experimental Physics</td>
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**Module coordinator**

chairperson of examination committee

**Module offered by**

Faculty of Physics and Astronomy

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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

(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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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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Module title

Current Topics in Theoretical Physics

Abbreviation

11-BXT5-112-m01

Module coordinator

Chairperson of examination committee

Module offered by

Faculty of Physics and Astronomy

ECTS

5

Method of grading

Only after succ. compl. of module(s)

Duration

1 semester

Module level

Undergraduate

Other prerequisites

Approval by examination committee required.

Contents

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

Intended learning outcomes

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

Courses

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

Method of assessment

(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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**Contents**

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

**Intended learning outcomes**

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

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

V + 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 is creditable for 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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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

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**Additional information**

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</table>

**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**

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

**Method of assessment**

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

--
Astro Physics and Particle Physics
(max. 27 ECTS credits)

Modules for advanced Bachelor's students offered by the Faculty with regard to preparation for Bachelor's thesis and specialisation in Master's programme.
Module title | Abbreviation
---|---
Astrophysics | 11-A4-072-m01

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

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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
History of astronomy, coordinates and time measurement, the solar system, size scales in outer space, telescopes and detectors, stellar structure, stellar atmospheres, stellar evolution, final stages of stellar evolution, interstellar medium, structure of the Milky Way, local universe, expanding space-time, galaxies, active galactic nuclei, large-scale structure of the universe, Friedmann World Models, thermodynamics of the early universe, primordial nucleosynthesis, cosmic microwave background radiation, structure formation, inflation

Intended learning outcomes
The students are familiar with the modern world view of Astrophysics. They know methods and tools for astrophysical observations and evaluations. They are able to use these methods to plan and analyse own observations. They know the structure of the universe, e.g. of stars and galaxies and understand the process of their development.

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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes)
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### Module title

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<th>Cosmology</th>
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### Abbreviation

11-AKM-092-m01

### Module coordinator

Managing Director of the Institute of Theoretical Physics and Astrophysics

### Module offered by

Faculty of Physics and Astronomy

### ECTS

| 6 |

### Method of grading

| numerical grade |

### Only after succ. compl. of module(s)

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### Duration

| 1 semester |

### Module level

| graduate |

### 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.

### Contents

Expanding space-time, Friedmannian cosmology, basics of general relativity, the early universe, inflation, dark matter, primordial nucleosynthesis, cosmic microwave background, structure formation, supercluster, galaxies and galaxy clusters, intergalactic medium, cosmological parameters

### Intended learning outcomes

The students have basic knowledge of cosmology. They know the theoretical methods of cosmology and are able to relate them to observations. They have gained insights into current research topics and are able to work on scientific questions.

### Courses

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

### Method of assessment

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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<td>Plasma-Astrophysics</td>
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</table>

**Contents**


**Intended learning outcomes**

The students have basic knowledge of Plasma Astrophysics. They have mastered the theoretical description of motion and acceleration of charged particles in space, they know corresponding measuring methods and can compare and evaluate theory and experiments.

**Courses**

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

**Method of assessment**

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

--
Module title | Abbreviation
--- | ---
Astronomical Methods | 11-ASM-131-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

Methods of observational astronomy across the electromagnetic spectrum. Extraction and reduction of observational data from radio, optical, X-ray and gamma-ray telescopes.

Intended learning outcomes

Overview of the methods used in observational astronomy in various parts of the electromagnetic spectrum (radio, optical, X-ray and gamma-ray energies). Knowledge of principles and applications of these methods and ability to conduct astronomical observations.

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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes)
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Module title: Introduction to Space Physics  
Abbreviation: 11-ASP-092-m01

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

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

Duration: 1 semester  
Module level: graduate  
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.

Contents:
1. Overview
2. Dynamics of charged particles in magnetic and electric fields
3. Elements of space physics
4. The sun and heliosphere
5. Acceleration and transport of energetic particles in the heliosphere
6. Instruments to measure energetic particles in extraterrestrial space

Intended learning outcomes:
The students have basic knowledge of Space Physics, in particular of the characterisation of the dynamics of charged particles in space and in the heliosphere. They know relevant parameters, theoretical concepts and measuring methods.

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

Method of assessment:
Type: 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 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:

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

Bachelor’s with 1 major Physics (2012)  
JMU Würzburg • generated 23-Aug-2021 • exam. reg. data record Bachelor (180 ECTS) Physik - 2012  
page 108 / 157
Module title: Atmosphere and Space Physics

Abbreviation: 11-AWP-092-m01

Module coordinator: Managing Director of the Institute of Theoretical Physics and Astrophysics

Module offered by: Faculty of Physics and Astronomy

ECTS: 6

Method of grading: numerical grade

Only after succ. compl. of module(s): --

Duration: 1 semester

Module level: graduate

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.

Contents:

Intended learning outcomes:
The students have knowledge of the physics of planetary atmospheres, especially of the atmosphere of the Earth and near-Earth space. They are able to apply the acquired knowledge to the solution of problems of interplanetary space missions.

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

Method of assessment:
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 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 or English

Allocation of places: --

Additional information: --

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**Contents**

Plasma Astrophysics: Dynamics of charged particles in electric and magnetic fields, Magnetohydrodynamics, Transport equations for energetic particles, Properties of magnetic turbulence, Propagation of solar particles within the solar wind, Particle acceleration via shock waves and via interaction with plasma turbulence, Particle acceleration and transport in galaxies and other astrophysical objects, Cosmic radiation.

**Intended learning outcomes**

The students know the principles of Plasma Physics, especially the description of transport phenomena in plasmas. They are able to solve basic problems of Plasma Physics and to apply this knowledge to Astrophysics.

**Courses**

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

**Method of assessment**

(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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<td>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.</td>
</tr>
</tbody>
</table>

**Contents**


**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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

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## Module title
Computational Astrophysics

## Abbreviation
11-NMA-111-m01

### Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

### Module offered by
Faculty of Physics and Astronomy

### ECTS
6

### Method of grading
numerical grade

### Only after succ. compl. of module(s)
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### Duration
1 semester

### Module level
graduate

### 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.

### Contents

### Intended learning outcomes
The students are able to solve typical problems and equations of Astrophysics and other subdisciplines of Physics with the help of numerical simulations. They are especially capable of choosing adequate strategies to approach such problems and of validating the results.

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

### Method of assessment
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)

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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### Referred to in LPO I
(examination regulations for teaching-degree programmes)
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<td>Supersymmetry I and II</td>
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</table>

**Contents**


**Intended learning outcomes**

The students have knowledge of the mathematical and physical principles of supersymmetry and supersymmetric models. They understand the theory's formalism and recognise its connections to other models as well as its importance for phenomenology of elementary particles.

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

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### Module title
Renormalization Theory

### Abbreviation
11-RNT-092-m01

### Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

### Module offered by
Faculty of Physics and Astronomy

### ECTS
6

### Method of grading
numerical grade

### Only after succ. compl. of module(s)
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### Duration
1 semester

### Module level
graduate

### 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.

### Contents

### Intended learning outcomes
The students have gained an overview of renormalisation group methods for non-linear partial differential equations. They know important examples and corresponding solving methods and are able to apply them to specific tasks.

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

### Method of assessment
(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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<td>Relativistic Quantumfield Theory</td>
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**Module coordinator**
Managing Director of the Institute of Theoretical Physics and Astrophysics

**Module offered by**
Faculty of Physics and Astronomy

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**Duration** 1 semester  
**Module level** graduate

**Other prerequisites**
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**Contents**

**Intended learning outcomes**
The students have mastered the principles and underlying mathematics of relativistic quantum field theories. They know how to use perturbation theory and how to apply Feynman rules. They are able to calculate basics processes in the framework of quantum electrodynamics in leading order. Moreover, they have a basic understanding of radiative corrections and renormalisation.

**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 is creditable for 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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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
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**Module title** | **Abbreviation**  
---|---  
Theory of Relativity | 11-RTT-092-m01  

**Module coordinator**  
Managing Director of the Institute of Theoretical Physics and Astrophysics

**Module offered by**  
Faculty of Physics and Astronomy

**ECTS** | **Method of grading** | **Only after succ. compl. of module(s)** | **Other prerequisites**  
---|---|---|---  
6 | numerical grade | -- | 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**
Mathematical foundations of the theory of relativity; differential forms; brief summary of special relativity; elements of differential geometry; electrodynamics as an example of a relativistic gauge theory; field equations of general relativity; stellar models; introduction to cosmology; Hamiltonian formulation

**Intended learning outcomes**
The students are familiar with the basic physical and mathematical concepts of general relativity. They have a mathematical understanding of the formulation of general relativity on the basis of differential forms. They are able to apply the acquired knowledge to problems of Astrophysics and cosmology.

**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 is creditable for 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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<td>Theoretical Elementary Particle Physics</td>
<td>11-TEP-092-m01</td>
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**Module coordinator**
Managing Director of the Institute of Theoretical Physics and Astrophysics

**Module offered by**
Faculty of Physics and Astronomy

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**Duration**
1 semester

**Module level**
graduate

**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.

**Contents**

**Intended learning outcomes**
The students are familiar with the mathematical methods of Elementary Particle Physics. They understand the structure of the standard model based on symmetry principles and experimental observations. They know calculation methods for the processing of simple problems and processes of Elementary Particle Physics. Furthermore, they know the tests and limits of the standard model and the basics of extended theories.

**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 is creditable for 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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**Referred to in LPO I**
(examination regulations for teaching-degree programmes)
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Module title | Abbreviation
---|---
Experimental Particle Physics | 11-TPE-092-m01

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

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| 4 | numerical grade | 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 with modern particle detectors at the LHC and at the Tevatron. Discovery of the Higgs boson. Search for supersymmetry and other physics beyond the standard model. Determination of the top quark mass and W mass as well as other parameters of the standard model. Introduction to modern methods of analysis and assessment of systematic errors.

Intended learning outcomes

The students are familiar with the principles of modern particle detector physics, especially with currently open questions of Particle Physics, which are examined by using these detectors. They know modern methods of analysis and are able to put results into context and to assess their systematic uncertainties.

Courses

<table>
<thead>
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<th>type, number of weekly contact hours, language — if other than German</th>
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Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 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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Referred to in LPO I (examination regulations for teaching-degree programmes)

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### Module Title

**Particle Physics (Standard Model)**  
Abbreviation: 11-TPS-092-m01

### Module Coordinator

Managing Directors of the Institute of Applied Physics and the Institute of Theoretical Physics and Astrophysics

### Module Offered by

Faculty of Physics and Astronomy

### ECTS

8

### Method of Grading

Only after succ. compl. of module(s)

### Duration

1 semester

### Module Level

Graduate

### 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.

### Contents

Introduction to the theory of electroweak interaction and spontaneous symmetry breaking. Experiments on the standard model and determination of model parameters.

### Intended Learning Outcomes

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

### Courses

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

### Method of Assessment

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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</table>

**Contents**

Theoretical Astrophysics, models for the description of complex observation results, numeric simulations.

**Intended learning outcomes**

The students have basic knowledge of the methods of Theoretical Astrophysics. They are able to design complex observations and to test the models with the help of simulations.

**Courses**

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

**Method of assessment**

written examination (approx. 120 minutes)

**Allocation of places**

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**Additional information**

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

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Module title | Abbreviation
--- | ---
**Strong Interaction in Accelerator Experiments** | 11-WWB-102-m01

**Module coordinator**
Managing Director of the Institute of Applied Physics

**Module offered by**
Faculty of Physics and Astronomy

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**Duration**
1 semester

**Module level**
graduate

**Other prerequisites**
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**Contents**

**Intended learning outcomes**
The students know the basic organisation of QCD processes. They are able to interpret results of accelerator experiments. They have knowledge of methods of data analysis, understand the underlying theories and are able to apply them.

**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 is creditable for 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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### Contents

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

### Intended learning outcomes

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

### Courses

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

### Method of assessment

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

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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<th>Other prerequisites</th>
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<td>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.</td>
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</tbody>
</table>

**Contents**

- Mathematical foundations of the theory of relativity; differential forms; brief summary of special relativity; elements of differential geometry; electrodynamics as an example of a relativistic gauge theory; field equations of general relativity; stellar models; introduction to cosmology; Hamiltonian formulation

**Intended learning outcomes**

- The students are familiar with the basic physical and mathematical concepts of general relativity. They have a mathematical understanding of the formulation of general relativity on the basis of differential forms. They are able to apply the acquired knowledge to problems of Astrophysics and cosmology.

**Courses**

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

**Method of assessment**

- 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**

- --

**Additional information**

- --

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

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<table>
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<th>Module title</th>
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<td>Special Theory of Relativity</td>
<td>11-SRT-112-m01</td>
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<tr>
<td>Managing Director of the Institute of Theoretical Physics and Astrophysics</td>
<td>Faculty of Physics and Astronomy</td>
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</table>

**Contents**

Mathematical principles; differential forms; special relativity; Minkowski space; Lorentz transformation, Hamiltonian equation of motion; relativistic free particle

**Intended learning outcomes**

The students are familiar with the physical concepts and mathematical principles of special relativity. They are familiar with modern mathematical formulation of special relativity. They are able to apply the acquired knowledge to problems of special relativity.

**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 is creditable for 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**

--

**Additional information**

--

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

--
### Module title

**Particle Radiation Detectors**

### Abbreviation

11-DTS-111-m01

---

### Module coordinator

Managing Director of the Institute of Applied Physics

### Module offered by

Faculty of Physics and Astronomy

### ECTS

4

### Method of grading

Only after succ. compl. of module(s)

### Numerical grade

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### Duration

1 semester

### Module level

graduate

### 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.

---

### Contents

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

### Intended learning outcomes

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

---

### Courses

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

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### Method of assessment

(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

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### Allocation of places

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### Additional information

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### Referred to in LPO I

(examination regulations for teaching-degree programmes)

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<td>Current Topics in Experimental Physics</td>
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<td>1 semester</td>
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</table>

**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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

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## Current Topics in Experimental Physics

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### Module coordinator
chairperson of examination committee

### Module offered by
Faculty of Physics and Astronomy

### ECTS
6

### Method of grading
Numerical grade

### Only after succ. compl. of module(s)

### Duration
1 semester

### Module level
Undergraduate

### Other prerequisites
Approval by examination committee required.

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

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

### Courses
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 is creditable for 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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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

V + 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 is creditable for 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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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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## Module title
Current Topics in Theoretical Physics

## Abbreviation
11-BXT6-112-m01

### Module coordinator
Chairperson of examination committee

### Module offered by
Faculty of Physics and Astronomy

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

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

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

### Method of assessment
(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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### Referred to in LPO I
(examination regulations for teaching-degree programmes)
**Module title**
Current Topics in Theoretical Physics

**Abbreviation**
11-BXT8-112-m01

**Module coordinator**
chairperson of examination committee

**Module offered by**
Faculty of Physics and Astronomy

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**Duration**
1 semester

**Module level**
undergraduate

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

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

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

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

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**Module title**  
Particle Radiation Detectors

**Abbreviation**  
11-DTS-131-m01

**Module coordinator**  
Managing Director of the Institute of Applied Physics

**Module offered by**  
Faculty of Physics and Astronomy

**ECTS**  
4

**Method of grading**  
Only after succ. compl. of module(s)

**Duration**  
1 semester

**Module level**  
graduate

**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 semesters.

**Contents**

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

**Intended learning outcomes**

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

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

V + 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 is creditable for 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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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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Complex Systems, Quantumcontrol and Biophysics
(max. 27 ECTS credits)

Modules for advanced Bachelor's students offered by the Faculty with regard to preparation for Bachelor's thesis and specialisation in Master's programme.
<table>
<thead>
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<td>Biophysical Measurement Technology in Medical Science</td>
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<tr>
<td>1 semester</td>
<td>graduate</td>
<td>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.</td>
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<table>
<thead>
<tr>
<th>Intended learning outcomes</th>
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<tbody>
<tr>
<td>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.</td>
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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

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</table>
Module title: Laboratory and Measurement Technology in Biophysics
Abbreviation: 11-LMB-092-m01

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

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

Duration: 1 semester
Module level: graduate
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.

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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes):
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Module title | Abbreviation
---|---
Nano-Optics | 11-NOP-092-m01

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

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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

Intended learning outcomes
The students have specific and advanced knowledge in the field of nano-optics. They are familiar with the theoretical principles and application areas of nano-optics and with current developments in this field.

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 is creditable for 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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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
## Module Catalogue for the Subject Physics
### Bachelor's with 1 major, 180 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics of Complex Systems</td>
<td>11-PKS-092-m01</td>
</tr>
</tbody>
</table>

### Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

### Module offered by
Faculty of Physics and Astronomy

### ECTS | Method of grading | Only after succ. compl. of module(s) | Other prerequisites |
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>6</td>
<td>numerical grade</td>
<td>--</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Duration | Module level | Contents |
|------------|-------------|----------|
| 1 semester | graduate    | 1. Theory of critical phenomena in thermal equilibrium  
2. Introduction into the physics out of equilibrium  
3. Entropy production and fluctuation  
4. Phase transitions away from equilibrium  
5. Universalit  
6. Spin glasses  
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
R + V (no information on SWS (weekly contact hours) and course language available)

### Method of assessment
(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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<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantum Information and Quantum Computing</td>
<td>11-QIC-092-m01</td>
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</table>

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<th>Module coordinator</th>
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**Contents**

The first part introduces the theoretical concepts of quantum information and quantum computers. It discusses the main quantum algorithms. The second part discusses experimental possibilities for the realisation of entangled states. One of the main topics is the production, controlling and manipulation of coherent two-electron spin states. The third part covers the description and explanation of decoherence of quantum mechanical states.

**Intended learning outcomes**

The students have an advanced understanding of quantum theory and basic knowledge of quantum calculation. They are able to solve simple problems of quantum information theory.

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

**Method of assessment**  
(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)  
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Language of assessment: German, English

**Allocation of places**

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**Additional information**

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

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<table>
<thead>
<tr>
<th>Module title</th>
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</thead>
<tbody>
<tr>
<td>Statistics, Data Analysis and Computer Physics</td>
<td>11-SDC-092-m01</td>
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<thead>
<tr>
<th>Module coordinator</th>
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<td>Managing Director of the Institute of Applied Physics</td>
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<th>Duration</th>
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**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 is creditable for bonus)

1. written examination (approx. 90 minutes) or
2. 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
3. project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or
4. 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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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<table>
<thead>
<tr>
<th>Module title</th>
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<tbody>
<tr>
<td>Current Topics in Experimental Physics</td>
<td>11-BXE5-112-m01</td>
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<table>
<thead>
<tr>
<th>Module coordinator</th>
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<tbody>
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</table>

**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

--
## Module Catalogue for the Subject Physics

### Bachelor’s with 1 major, 180 ECTS credits

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<tr>
<th>Module title</th>
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<tr>
<td>Current Topics in Experimental Physics</td>
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<tbody>
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</table>

**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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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<tr>
<td>Current Topics in Experimental Physics</td>
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Contents

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

Intended learning outcomes

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

Courses

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

Method of assessment

(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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<tr>
<td>Current Topics in Theoretical Physics</td>
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**Contents**

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

**Intended learning outcomes**

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

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

V + 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 is creditable for bonus)

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Language of assessment: German or English

**Allocation of places**

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**Additional information**

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

--
Module title | Abbreviation
--- | ---
Current Topics in Theoretical Physics | 11-BXT6-112-m01

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

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

Intended learning outcomes
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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 is creditable for bonus)
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Language of assessment: German or English

Allocation of places
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Additional information
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## Module Catalogue for the Subject Physics
Bachelor's with 1 major, 180 ECTS credits

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<table>
<thead>
<tr>
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<td>(examination regulations for teaching-degree programmes)</td>
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</table>
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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<td>Bachelor Thesis Physics</td>
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**Contents**

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

**Intended learning outcomes**

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

**Courses**

no courses assigned

**Method of assessment**

written thesis (approx. 25 pages)

Language of assessment: German or English

**Allocation of places**

--

**Additional information**

--

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

--
Subject-specific Key Skills
(16 ECTS credits)

Modules 11-P-MR and 11-HS must be successfully completed.
Compulsory Courses
(10 ECTS credits)

Modules 11-P-MR and 11-HS must be successfully completed.
<table>
<thead>
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<th>Module title</th>
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<tbody>
<tr>
<td>Advanced Seminar Experimental/Theoretical Physics</td>
<td>11-HS-092-m01</td>
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<th>Only after succ. compl. of module(s)</th>
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<tbody>
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<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance and successful preparation of seminar presentation.</td>
</tr>
</tbody>
</table>

**Contents**

Current issues of Theoretical/Experimental Physics.

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

Talk (approx. 30 to 45 minutes) with discussion

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

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## Module title
Mathematical Methods of Physics

### Abbreviation
11-P-MR-092-m01

### Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

### Module offered by
Faculty of Physics and Astronomy

### ECTS
6

### Method of grading
Only after succ. compl. of module(s)

### Duration
2 semester

### Module level
undergraduate

### Other prerequisites
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### 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 is creditable for 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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### 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"
Compulsory Electives
(6 ECTS credits)

6 ECTS credits must be achieved in mandatory electives.
## Module title
Computational Physics

## Abbreviation
11-A1-092-m01

## Module coordinator
Managing Director of the Institute of Theoretical Physics and Astrophysics

## Module offered by
Faculty of Physics and Astronomy

## ECTS
6

## Method of grading
Numerical grade

## Only after succ. compl. of module(s)
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## Duration
1 semester

## Module level
Undergraduate

## 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.

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

## Method of assessment
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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## Referred to in LPO I
(examination regulations for teaching-degree programmes)

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### Module title
Electronics

### Abbreviation
11-A2-092-m01

### Module coordinator
Managing Director of the Institute of Applied Physics

### Module offered by
Faculty of Physics and Astronomy

### ECTS
6

### Method of grading
Only after succ. compl. of module(s)

### Numerical grade
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### Duration
1 semester

### Module level
undergraduate

### 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.

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

### Method of assessment
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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### Referred to in LPO I
(examination regulations for teaching-degree programmes)

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**Module title**  
Laboratory and Measurement Technology

**Abbreviation**  
11-A3-072-m01

<table>
<thead>
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**Duration**  
1 semester  
**Module level**  
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 is creditable for 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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**Referred to in LPO I**  
(examination regulations for teaching-degree programmes)  
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## Module catalogue for the subject Physics

### Bachelor's with 1 major, 180 ECTS credits

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### Module offered by

- chairperson of examination committee
- Faculty of Physics and Astronomy

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### Contents

- Subject competencies for physicists.

### Intended learning outcomes

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

### Courses

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

### Method of assessment

- 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

- --

### Additional information

- --

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### Module Catalogue for the Subject Physics

**Bachelor's with 1 major, 180 ECTS credits**

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### Courses

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

### Method of assessment

- a) written examination (approx. 120 minutes) or
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- 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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### Referred to in LPO I (examination regulations for teaching-degree programmes)

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