Subdivided Module Catalogue
for the Subject

Functional Materials
as a Bachelor’s with 1 major
with the degree "Bachelor of Science"
(180 ECTS credits)

Examination regulations version: 2021
Responsible: Faculty of Chemistry and Pharmacy
Responsible: Chair of Chemical Technology of Material Synthesis
Course of Studies - Contents and Objectives

The Bachelor of Science program Functional Materials at the faculty of Chemistry and Pharmacy prepares students for research and development occupations of both a scientific and a practical nature in the field of materials and natural sciences. Students learn the basic methodical principles of scientific work. The study program’s interdisciplinary focus enables students to obtain extensive fundamental knowledge of the fields of chemistry, physics and mathematics. In addition, they acquire expert knowledge of the following engineering and natural sciences subjects: electronics, engineering mechanics, materials science, molecular materials, and compound materials. Close cooperation with the Fraunhofer Institute for Silicate Research ISC, Würzburg-Schweinfurt University of Applied Sciences, the Bavarian Center for Applied Energy Research and the SKZ plastics center guarantees an interdisciplinary education. Thanks to this, students are introduced to multifaceted topics relating to modern functional materials. By means of their bachelor's thesis, students show that they have the ability to act largely independently to solve a specific, time-limited experimental or theoretical assignment of engineering or natural sciences tasks. The results of the bachelor's thesis are presented and defended in a colloquium. The Bachelor of Science degree qualifies students for an occupation of both a scientific and a practical nature in the field of materials and natural sciences in general and of functional materials in particular. However, this generally requires a further qualification to be acquired either through practical experience in industry or through a consecutive master's degree.
Abbreviations used

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

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

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

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

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

Conventions

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

Notes

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

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

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

In accordance with

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

**ASPO2015**

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

**17-Mar-2021 (2021-22)**

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

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**Key Skills Area (20 ECTS credits)**

**General Key Skills (5 ECTS credits)**

Students may select modules offered as part of the pool of general transferable skills (ASQ) of JMU.

**Subject-specific Key Skills (15 ECTS credits)**

**Thesis (12 ECTS credits)**

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Bachelor’s with 1 major Functional Materials (2021)
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<th>Module offered by</th>
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<tr>
<td>degree programme coordinator Funktionswerkstoffe (Functional Materials)</td>
<td>Chair of Chemical Technology of Material Synthesis</td>
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<th>Only after succ. compl. of module(s)</th>
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<th>Other prerequisites</th>
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<td>Please consult with course advisory service in advance.</td>
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**Contents**
Practical work related to functional materials in a foreign country.

**Intended learning outcomes**
The students apply their knowledge in practical laboratory work and gain basic understanding of the language and the culture of the country visited.

**Courses** (type, number of weekly contact hours, language — if other than German)
P (4)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
- report (approx. 2 pages);
- proof of having completed lab course
- Language of assessment: German and/or English or potentially language of the respective country

**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>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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<td>Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.</td>
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**Contents**

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

**Intended learning outcomes**

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

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

V (1) + Ü (1)

Module taught in: Ü: German or English

**Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)**

written examination (approx. 120 minutes)

Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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

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

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<tr>
<td>chairperson of examination committee Funktionswerkstoffe</td>
<td>Chair of Chemical Technology of Material Synthesis</td>
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### Contents

Working on a defined problem from the field of functional materials using scientific methods.

### Intended learning outcomes

The student is able to work on a defined problem using scientific methods and to present the results in written form.

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

No courses assigned to module

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

Bachelor’s thesis (20 to 40 pages)  
Language of assessment: German and/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 | Biochemistry 1
---|---
Abbreviation | 08-BC1-152-m01

Module coordinator | holder of the Chair of Biochemistry
Module offered by | Chair of Biochemistry

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

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

Contents
The module imparts the basic knowledge of biochemistry by lectures and tutorials. Main topics of the module Biochemistry 1 are particularly the biochemistry of proteins (amino acids, peptide bond, primary, secondary, tertiary and quaternary structure), catalytic strategies and enzyme kinetics, carbohydrate metabolism (glycolysis, gluconeogenesis, citric acid cycle, cellular respiration, photosynthesis), fatty acid metabolism (beta-oxidation, fatty acid synthesis), nucleotide metabolism, urea cycle and metabolism of amino acids. Additionally the module conveys basic knowledge about the structure of DNA and the basics of passing and transformation of genetic information (central dogma).

Intended learning outcomes
The student has basic knowledge in the covered subject areas of biochemistry. He/She is able to describe the basic biochemical processes in cellular systems.

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
written examination (approx. 60 to 90 minutes)

Allocation of places
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Additional information
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§ 62 I Nr. 2
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<td>holder of the Chair of Functional Materials in Medicine and Dentistry</td>
<td>Faculty of Medicine</td>
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<th>ECTS</th>
<th>Method of grading</th>
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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>undergraduate</td>
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</table>

**Contents**

Fundamental and specific knowledge about biomaterials out of metals, ceramics and polymers with surface modification and characterisation. Fabrication as well as examples for application will be addressed. Modern approaches in biomaterial research including hydrogels, additive manufacturing, 3D cell scaffolds and materials for tissue engineering will also be discussed.

**Intended learning outcomes**

Students acquire fundamental knowledge in the field of biomaterials, their use in clinics as well as methods for biomaterial fabrication.

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

V (4) + P (2)

**Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)**

a) assessment and b) Vortestate/Nachtestate (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical assignments (2 to 4 random examinations)

Assessment offered: Once a year, summer semester

Language of assessment: German and/or English creditable for bonus

**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: Computational Mathematics  
Abbreviation: 10-M-COM-152-m01

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

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

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

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

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

Courses (type, number of weekly contact hours, language — if other than German):
V (1) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus):
Project in the form of programming exercises (approx. 20 to 25 hours)
Assessment offered: Once a year, winter semester
Language of assessment: German and/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):
§ 22 II Nr. 3 f)
Module title: Data Bases
Abbreviation: 10-I-DB-152-m01

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

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

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

Contents:
Relational algebra and complex SQL statements; database planning and normal forms; transaction management.

Intended learning outcomes:
The students possess knowledge about database modelling and queries in SQL as well as transactions.

Courses:
V (2) + Ü (2)

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

Allocation of places:
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Additional information:
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Referred to in LPO I (examination regulations for teaching-degree programmes):
§ 49 I Nr. 1b
§ 69 I Nr. 1b
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Introduction to Functional Analysis</td>
<td>10-M-FANaf-152-m01</td>
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<tr>
<td>for Students of other Subjects</td>
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<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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</table>

**Contents**

Banach spaces and Hilbert spaces, bounded operators, principles of functional analysis.

**Intended learning outcomes**

The student knows the fundamental concepts and methods of functional analysis as well as the pertinent proof methods, is able to apply methods from linear algebra and analysis to functional analysis, and realises the broad applicability of the theory to other branches of mathematics.

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

V (4) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes, usually chosen) or b) oral examination of one candidate each (15 to 30 minutes) or c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)

Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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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 Computer Science for Students of all Faculties**

### Abbreviation

10-I-EIN-152-m01

### Module coordinator

Dean of Studies Informatik (Computer Science)

### Module offered by

Institute of Computer Science

### ECTS

10

### Method of grading

Numerical grade

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

--

### Duration

1 semester

### Module level

Undergraduate

### Other prerequisites

--

### Contents

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

### Intended learning outcomes

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

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

V (4) + Ü (2)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

Written examination (approx. 60 to 120 minutes)

Language of assessment: German and/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
---|---
Introduction to Nanoscience | 11-N-EIN-152-m01

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

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

Duration | Module level | Other prerequisites
---|---|---
2 semester | undergraduate | Admission prerequisite to assessment: regular attendance (minimum 85% of sessions).

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

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

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + S (2)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) talk (30 to 45 minutes) with discussion and b) written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places
--

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

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module title: Introduction to the Physics of Functional Materials
Abbreviation: 11-TMS-212-m01

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

ECTS: 5
Method of grading: numerical grade
Duration: 1 semester
Module level: undergraduate

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

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

Courses (type, number of weekly contact hours, language — if other than German):
V (3) + R (1)
Module taught in: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus):
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes).

If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.
Assessment offered: Once a year, summer semester
Language of assessment: German and/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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<td>Experimental Chemistry</td>
<td>08-AC-ExChem-152-m01</td>
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<th>Module offered by</th>
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<tbody>
<tr>
<td>lecturer of lecture &quot;Experimentalchemie&quot; (Experimental Chemistry)</td>
<td>Institute of Inorganic Chemistry</td>
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<td>1 semester</td>
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### Contents

The module provides an overview of the fundamental knowledge of chemistry. Emphasis is placed on the material and particle level, metals, acid-base reactions, the periodic table, chemical equilibrium and complexometry.

### Intended learning outcomes

The student understands the principles of the periodic table and can obtain information from it. He/she is proficient in basic models of the structure of matter and can describe them properly. He/she can depict chemical reactions using typical chemical formula language and interpret them by identifying the type of reaction.

### Courses

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

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### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

written examination (approx. 90 minutes)

Language of assessment: German and/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>Module title</th>
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<tr>
<td>Advanced and Computational Data Analysis</td>
<td>11-P-FR2-152-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**
undergraduate

**Other prerequisites**
Students are highly recommended to complete module 11-P-FR1 prior to completing module 11-P-FR2.

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

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

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

V (1) + Ü (1)

**Method of assessment**
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
Exercises (successful completion of approx. 50% of approx. 10 exercise sheets)
Assessment offered: Once a year, summer semester

**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>Module title</th>
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<tr>
<td>Ordinary Differential Equations for students of other subjects</td>
<td>10-M-DGLaf-152-m01</td>
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<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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<td>1 semester</td>
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</table>

**Contents**

Existence and uniqueness theorem; continuous dependence of solutions on initial values, systems of linear differential equations, matrix exponential series, linear differential equations of higher order.

**Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods of the theory of ordinary differential equations. He/she is able to apply these methods to practical problems.

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

V (4) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes, usually chosen) or b) oral examination of one candidate each (15 to 30 minutes) or c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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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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<th><strong>Module title</strong></th>
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<td>Basics of Electronics 1 &amp; 2</td>
<td>99-EL-212-m01</td>
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<tr>
<td>Dean of the Faculty of Electrical Engineering at the University of Applied Sciences Würzburg-Schweinfurt</td>
<td>University of Applied Sciences Würzburg-Schweinfurt (FHWS)</td>
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<td>2 semester</td>
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<tr>
<th><strong>Contents</strong></th>
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<tbody>
<tr>
<td>Theoretical and practical basics of electricity, passive linear networks, semiconductor basics. Theoretical and practical basics of electrical measurement technology, basic circuits, basic elements of digital technology, switching networks and switching mechanisms, microprocessors.</td>
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<table>
<thead>
<tr>
<th><strong>Intended learning outcomes</strong></th>
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<tbody>
<tr>
<td>The student has basic knowledge of theoretical and practical electricity theory, in particular of passive linear networks and semiconductors.</td>
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<th><strong>Courses</strong> (type, number of weekly contact hours, language — if other than German)</th>
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<td>Language of assessment: German and/or English</td>
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</table>
### Module title
**Principles of Tissue Engineering**

### Abbreviation
03-FU-TE-152-m01

### Module coordinator
holder of the Chair of Regenerative Medicine

### Module offered by
Faculty of Medicine

### ECTS
5

### Method of grading
- numerical grade

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

### Duration
1 semester

### Module level
undergraduate

### Other prerequisites
--

### Contents
Medical foundations of organ and tissue damage, medical implants, xenotransplantation, cell culture technology, principles of tissue engineering, 2D and 3D tissue models, stem cell technology.

### Intended learning outcomes
The students acquire knowledge in the medical fundamentals of organ and tissue damage, medical implants, xenotransplantation, cell culture technology, principles of tissue engineering, 2D and 3D tissue models, stem cell technology.

### Courses (type, number of weekly contact hours, language — if other than German)
V (4)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

**a)** written examination (approx. 90 to 180 minutes) or **b)** oral examination of one candidate each (20 to 30 minutes) or **c)** oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or **d)** log (approx. 20 pages) or **e)** presentation (approx. 30 minutes)

Assessment offered: Once a year, summer semester

Language of assessment: German and/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
Principles of quantum mechanics and spectroscopy for engineering students

### Abbreviation
08-PC-QMS-FU-152-m01

### Module coordinator
Lecturer of lecture "Grundlagen der Quantenmechanik und Spektroskopie" (Principles of Quantum Mechanics and Spectroscopy)

### Module offered by
Institute of Physical and Theoretical Chemistry

### ECTS
8

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

### Duration
1 semester

### Module level
Undergraduate

### Other prerequisites
--

### Contents
This module introduces students to the fundamental principles of quantum mechanics. It analyses molecules on the basis of the following models: particle in a box, harmonic oscillator and rigid rotor. As regards spectroscopy, the module focuses on vibrational spectroscopy, angular momentum quantisation, microwave spectroscopy and UV-VIS spectroscopy. In addition, the module discusses linear operators, eigenvalue problems, matrix representation, differential equations, Fourier transform and orthogonal functions as mathematical bases of the topics listed above.

### Intended learning outcomes
Students are able to explain key models of quantum mechanics and to apply them to molecules. They are able to describe different spectroscopic methods. In addition, students know how to apply the mathematical bases of quantum mechanics.

### Courses
(type, number of weekly contact hours, language — if other than German)
V (4) + Ü (2)

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)
Language of assessment: German and/or English
Creditable for bonus

### 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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<td>Basics of Applied Mechanics</td>
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<tr>
<td>Dean of the Faculty of Mechanical Engineering at the University of Applied Sciences Würzburg-Schweinfurt</td>
<td>University of Applied Sciences Würzburg-Schweinfurt (FHWS)</td>
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**Contents**
Basics of statistics, strength of materials and dynamics.

**Intended learning outcomes**
The students gain methodological competence in determining forces and stress resultants, in calculating tensions and deformations and in dimensioning components.

**Courses** (type, number of weekly contact hours, language — if other than German)
V (3) + Ü (1)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)
Assessment offered: Once a year, winter semester
Language of assessment: German and/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
Principles of Cell Biology and Tissue Regeneration

Abbreviation
03-FU-Zell-152-m01

Module coordinator
holder of the Chair of Orthopaedics (Jakob/Ebert)

Module offered by
Faculty of Medicine

ECTS
5

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

Duration
1 semester

Module level
undergraduate

Numerical grade
--

Other prerequisites
--

Contents
Foundations of cell biology (cell structure, organelles, DNA, replication, protein biosynthesis, signal transduction, cell metabolism, stem cells, viruses and prokaryotes, immune system).

Intended learning outcomes
Students acquire fundamental knowledge in cell and molecular biology.

Courses
(type, number of weekly contact hours, language — if other than German)
V (4)

Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Language of assessment: German and/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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<td>Industrial Internship</td>
<td>08-FU-IP1-212-m01</td>
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<tr>
<td>degree programme coordinator Funktionswerkstoffe (Functional Materials)</td>
<td>Chair of Chemical Technology of Material Synthesis</td>
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<td>Please consult with course advisory service in advance.</td>
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</table>

**Contents**

Internship in an industrial firm related to functional materials.

**Intended learning outcomes**

The students are familiar with procedures and methods in the industry.

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

P (4)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

report (5 to 10 pages)

Language of assessment: German and/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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<tbody>
<tr>
<td>Laboratory Course of Mechanical and Electrical Engineering</td>
<td>99-IP-212-m01</td>
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**Module coordinator**

Deans of the Faculties of Electrical Engineering and Mechanical Engineering at the University of Applied Sciences Würzburg-Schweinfurt

**Module offered by**

University of Applied Sciences Würzburg-Schweinfurt (FHWS)

<table>
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<td>Students are highly recommended to complete module 99-TM prior to completing module 99-IP as well as to complete modules 99-CA and 99-IP simultaneously.</td>
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**Contents**

Engineering laboratory and internship experiments.

**Intended learning outcomes**

The students have practical experiences in applying engineering methods in electrical and mechanical engineering.

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

P (5)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

report on practical course (15 to 30 pages)
Assessment offered: Once a year, summer semester
Language of assessment: German and/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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### Classical Physics 1 (Mechanics)

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

<table>
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<tr>
<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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**ECTS**: 8  
**Method of grading**: Only after succ. compl. of module(s)  
**Duration**: 1 semester  
**Module level**: undergraduate  
**Other prerequisites**: Admission prerequisite to assessment: completion of exercises (approx. 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the semester.

**Contents**

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

The students understand the basic contexts and principles of mechanics, vibration, waves and kinetic theory of gases. They are able to apply mathematical methods to the formulation of physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.

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

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

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

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

Allocation of places

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Additional information

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

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

§ 53 I Nr. 1 a)
§ 77 I Nr. 1 a)
Module title: Classical Physics 2 (Heat and Electromagnetism)
Abbreviation: 11-E-E-152-m01

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

Contents:
1. Thermodynamics (linked to 11-E-M); temperature and quantity of heat, thermometer, Kelvin scale;
2. Heat conduction, heat transfer, diffusion, convection, radiant heat;
3. Fundamental theorems of thermodynamics, entropy, irreversibility, Maxwell’s demon;
4. Heat engines, working diagrams, efficiency, example: Stirling engine;
5. Real gases and liquids, states of matter (also solids), van der Waals, critical point, phase transitions, critical phenomena (opalescence), coexistence region, Joule-Thomson;
6. Electrostatics, basic concepts: Electrical charge, forces; electric field, reps. field concept, field lines, field of a point charge;
7. Gaussian sentence, related to Coulomb’s law, definition of “river”; Gaussian surface, divergence theorem; special symmetries; divergence and GS in differential form;
8. Electrical potential, working in the E-box, electric. potential, potential difference, voltage; potential equation, equipotential surfaces; several important examples: Sphere, hollow sphere, capacitor plates, electric dipole; lace effects, Segner wheel;
9. Matter in the E-field, charge in a homogeneous field, Millikan experiment, Braun tube; electron: Field emission, thermionic emission, dipole in homogeneous and inhomogeneous field; induction, Faraday cage;
10. Capacitor, mirror charge, definition, capacity; plate and spherical capacitor; combination of capacitors; media in the capacitor; electrical polarisation, displacement and orientation polarisation, microscopic image; dielectric displacement; electrolytic capacitor; Piezoelectric effect;
11. Electricity, introduction, current density, drift velocity, conduction mechanisms;
12. Resistance and conductivity, resistivity, temperature dependence; Ohm’s law; realisations (resistive and non-ohmic, NTC, PTC);
13. Circuits, electrical networks, Kirchhoff’s rules (meshes, nodes); internal resistance of a voltage source, measuring instruments; Wheatstone bridge;
14. Power and energy in the circuit; Capacitor charge; galvanic element; thermovoltage;
15. Transfer mechanisms, conduction in solids: Band model, semiconductor; line in liquids and gases;
16. Magnetostatics, fundamental laws; permanent magnet, field properties, definitions and units; Earth’s magnetic field; Amper’s Law, analogous to e-box, magn. river, swirl;
17. Vector potential, formal derivation, analogous to electric scalar potential; calculation of fields, examples, Helmholtz coils;
18. Moving charge in the static magnetic field, current balance, Lorentz force, right-hand rule, electric motor; dipole field; movement paths, mass spectrometer, Wien filters, Hall effect; electron: e / m determination;
19. Matter in the magnetic field, effects of the field on matter, relative permeability, susceptibility; para-, dia-, ferromagnetism; magn. moment of the electron, behaviour at interfaces;
20. Induction, Faraday’s law of induction, Lenz’s rule, flux change, eddy electric field, Waltenhofen’s pendulum; Inductance,self-induction; applications: Transformer, generator;
21. Maxwell’s displacement current, choice of integration area, displacement current; Maxwell’s extension, wave equation; Maxwell equations;
22. AC: Fundamentals, sinusoidal vibrations, amplitude, period and phase; power and RMS value, ohmic resistance; Capacitive & inductive resistor, capacitor and coil, phase shift and frequency dependence; impedance: Complex resistance; performance of the AC;
23. Resonant circuits, combinations of RLC; series and parallel resonant circuit; forced vibration, damped harmonic oscillator (related to 11-E-M);
24. Hertz dipole, characteristics of irradiation, near field, far field; Rayleigh scattering; accelerated charge, synchrotron radiation, X-rays; 25. Electromagnetic waves: Principles, Maxwell’s determination to electromagnetism, radiation pressure (Poynting vector, radiation pressure).

**Intended learning outcomes**

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

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

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<th>Type</th>
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<tr>
<td>Ü</td>
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Module taught in: Ü: German or English

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

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

**Allocation of places**

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**Additional information**

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

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

- § 53 I Nr. 1 a)
- § 77 I Nr. 1 a)
### Module title
**Bachelor Thesis Functional Materials Defense**

### Abbreviation
08-FU-BT2-152-m01

### Module coordinator
Chairperson of examination committee Funktionswerkstoffe

### Module offered by
Chair of Chemical Technology of Material Synthesis

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### Contents
Presentation and defense of a scientific paper.

### Intended learning outcomes
The students are able to present and defend their scientific work.

### Courses (type, number of weekly contact hours, language — if other than German)
K (1)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
talk (approx. 20 minutes) with discussion (approx. 20 minutes)
Language of assessment: German and/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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<td>Construction, Calculation and Assembly of Technical Products</td>
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<td>Dean of the Faculty of Mechanical Engineering at the University of Applied Sciences Würzburg-Schweinfurt</td>
<td>University of Applied Sciences Würzburg-Schweinfurt (FHWS)</td>
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<td>1 semester</td>
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</table>

**Contents**

Comprehensive view of the process of product development, including the corresponding specialist subjects based on a selected example.

**Intended learning outcomes**

The students have professional and methodological competencies in the development of products with a focus on construction (CAD), calculation (CAE) and production (CAM), including prototyping and product validation.

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

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Assessment offered: Once a year, summer semester

Language of assessment: German and/or English creditable for bonus

**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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Material Sciences 1 (Basic introduction)

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<td>Chair of Chemical Technology of Material Synthesis</td>
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**Contents**

Part A Structure of materials
The students learn about the atomic structure of solid materials.

Part B Metallic Materials
The students learn about the structure of metallic materials as well as their mechanical properties including deformation and failure mechanism as well as the analysis of mechanical properties. In addition, the corrosion and corrosion protection of metallic materials is introduced.

Part C Numerical Methods
The students are introduced to numerical methods like finite element methods (FEM) and Monte-Carlo-Simulation.

**Intended learning outcomes**

The students know the structure of solids, thermodynamic properties like enthalpy and entropy, the laws of diffusion and lattice defects. They are familiar with deformation and corrosion mechanisms in metals. The students acquire knowledge about thermodynamic of solids. They understand phase transitions, alloys and phase separation of metals. The students can explain the deformation as well as hardening due to dislocations of metals. The students can apply FEM to simple problems and perform simulations based on the Monte-Carlo-method.

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

V (2) + Ü (1) + V (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Language of assessment: German and/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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<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**


**Intended learning outcomes**

The students acquire fundamental knowledge about fabrication and properties of the major classes of materials and are able to apply this to scientific problems.

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

V (3) + Ü (1)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Language of assessment: German and/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
---|---
Mathematics 1 for Students of Functional Materials | 10-M-FUN1-212-m01

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

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

Contents
Basics on numbers and functions, sequences and series, differential and integral calculus in one variable, vector spaces, simple differential equations.

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

Courses (type, number of weekly contact hours, language — if other than German)
V (5) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups of 2 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

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>Dean of Studies Mathematik (Mathematics)</td>
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</table>

**Contents**

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

**Intended learning outcomes**

The students get acquainted with fundamental concepts of advanced mathematics. They learn to apply these methods to problems in natural and engineering sciences, in particular in the technology of functional materials, and is able to interpret the results.

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

V (5) + Ü (2)

Module taught in: Ü: German or English

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups of 2 candidates (approx. 15 minutes per candidate)

Language of assessment: German and/or English

creditable for bonus

**Allocation of places**

--

**Additional information**

--

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

--
### Module title
Mathematics 3 for Students of Physics and related Disciplines (Differential Equations)

### Abbreviation
11-M-D-152-m01

### Module coordinator
Managing Director of 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
Undergraduate

### Other prerequisites
--

### Contents

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

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

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

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

### Courses
(type, number of weekly contact hours, language — if other than German)
V (4) + Ü (2)
Module taught in: Ü: German or English

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
written examination (approx. 120 minutes)
Language of assessment: German and/or English

### Allocation of places
--

### Additional information
--

### Referred to in LPO I
(examination regulations for teaching-degree programmes)
--
Module title
Mathematics 4 for Students of Physics and related Disciplines (Complex Analysis)
Abbreviation
11-M-F-152-m01

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

ECTS
8

Method of grading
numerical grade

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

Duration
1 semester

Module level
undergraduate

Other prerequisites
--

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

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

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

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

Courses (type, number of weekly contact hours, language — if other than German)
V (4) + Ü (2)
Module taught in: Ü: German or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
written examination (approx. 120 minutes)
Language of assessment: German and/or English

Allocation of places
--

Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
### Module title
Mathematical Methods of Physics for Students of Functional Materials

### Abbreviation
11-M-MR-FW-212-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
Only after succ. compl. of module(s)

### Duration
2 semester

### Module level
undergraduate

### Other prerequisites
--

### Contents
Fundamentals of mathematics and elementary calculation methods beyond the school subject, in particular for the introduction and preparation for the modules of theoretical physics and classical or experimental physics.

### Intended learning outcomes
The student has the knowledge of the basics of mathematics and the elementary computing techniques that are required in theoretical physics and experimental physics.

### Courses
V (2) + Ü (1) + V (2) + Ü (1)

Module taught in: German or English

### Method of assessment
(a) exercises (successful completion of approx. 50% of approx. 13 exercise sheets) or
(b) talk (approx. 15 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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<td>Molecular Materials (Practical Course)</td>
<td>08-FU-MoMaP-212-m01</td>
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<tr>
<td>degree programme coordinator Funktionswerkstoffe (Functional Materials)</td>
<td>Chair of Chemical Technology of Material Synthesis</td>
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<td>1 semester</td>
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</table>

**Contents**

Laboratory course to familiarise the students with experimental procedures in molecular materials including chemical synthesis, chemical and physical characterisation methods, as well as analysis of experimental data and scientific documentation, such as mesoporous, piezoelectric and electrochromic materials, polymer-based superabsorbers and nanoparticle based antireflex-coatings.

**Intended learning outcomes**

The students gain practical knowledge in the area of chemical synthesis, characterization methods, data analysis, as well as scientific documentation. By attending the experimental lab course the students consolidated their understanding of the relationship of structure and function of molecular materials.

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

| P (5) |

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

Vortestate/Nachtestate (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical performance (2 to 4 random examinations)

Language of assessment: German and/or English

**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
Molecular Materials (Lectures)

### Abbreviation
08-FU-MoMaV12-212-m01

### Module coordinator
degree programme coordinator Funktionswerkstoffe (Functional Materials)

### Module offered by
Chair of Chemical Technology of Material Synthesis

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<td>2 semester</td>
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### Contents
Chemical bonds and molecular interactions, supramolecular chemistry, molecular materials, colloids, nanoparticles, thin films.

### Intended learning outcomes
The student understands the relationship of physical, chemical and technological properties of materials and their structure. They know the significance of various inter and intramolecular interactions and how they determine the properties of molecular materials. They learn how to familiarize themselves with a scientific topic including a literature search, and how to give a presentation including discussion and feedback.

### Courses (type, number of weekly contact hours, language — if other than German)
V (3) + S (1) + V (3) + S (1)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
[a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)] as well as talk (approx. 30 minutes), weighted 75% : 25% creditable for bonus

Language of assessment: German and/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
Numerical Mathematics 1 for students of other subjects

Abbreviation
10-M-NUM1af-152-m01

Module coordinator
Dean of Studies Mathematik (Mathematics)

Module offered by
Institute of Mathematics

ECTS
10

Method of grading

Numerical grade

Only after succ. compl. of module(s)

Duration
1 semester

Module level
Undergraduate

Other prerequisites

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

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

Courses
(type, number of weekly contact hours, language — if other than German)
V (4) + Ü (2)

Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 180 minutes, usually chosen) or b) oral examination of one candidate each (15 to 30 minutes) or c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)

Language of assessment: German and/or English

creditable for bonus

Allocation of places

Additional information

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<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
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<td>1 semester</td>
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</table>

**Contents**

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

**Intended learning outcomes**

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

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

V (4) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes, usually chosen) or b) oral examination of one candidate each (15 to 30 minutes) or c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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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
Organic Chemistry for engineering students (practical course)

## Abbreviation
08-OCP1-FU-152-m01

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<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>holder of the Chair of Organic Chemistry II</td>
<td>Institute of Organic Chemistry</td>
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<td>1 semester</td>
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### Contents
This module gives students the opportunity to apply in practice the knowledge they have gained through the related lecture(s). After a safety briefing, the students autonomously conduct experiments in the laboratory. In addition to those experiments, students will be expected to take oral tests and write lab reports to demonstrate their knowledge. The course focuses on the safe handling of hazardous substances, simple experimental unit operations of organic chemistry, simple to multi-level syntheses and the analysis of the products.

### Intended learning outcomes
Students know how to safely handle hazardous substances. They are able to conduct simple experimental operations of organic chemistry. They are able to analyse the yield and purity of the products and identify possible error sources. They are able to connect the theoretical aspects covered in the lecture with practical experiments in the laboratory.

### Courses (type, number of weekly contact hours, language — if other than German)
P (4)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
Vortesten/Nachtesten (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical performance (2 to 4 random examinations)
Assessment offered: Once a year, winter semester
Language of assessment: German and/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

**Organic Chemistry 1**

**Abbreviation**

08-OC1-152-m01

### Module coordinator

holder of the Professorship of Organic Chemistry

### Module offered by

Institute of Organic Chemistry

### ECTS

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### Duration

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<tr>
<td>1 semester</td>
<td>undergraduate</td>
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### Contents

This module provides students with an overview of the fundamental principles of organic chemistry. It examines the bonding situation of carbon and introduces students to the nomenclature of simple and moderately complex organic compounds. The module also discusses the fundamental principles of stereochemistry, substitution, addition and elimination reactions as well as synthesis planning.

### Intended learning outcomes

Students know important categories of substances in organic chemistry. They are able to use different systems of nomenclature to determine simple substance names. Students are able to analyse the stereochemistry of molecules. They are able to describe and formulate some of the most important reactions in organic chemistry. For that purpose, they can analyse and categorise the characteristic reaction conditions and can use them for simple syntheses.

### Courses

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

V (3) + Ü (1)

### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Language of assessment: German and/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)

§ 62 I Nr. 2
Module title
Organic Chemistry 2 and analytical methods in organic chemistry

Abbreviation
08-OC2-152-m01

Module coordinator
holder of the Chair of Physically Organic Chemistry

Module offered by
Institute of Organic Chemistry

ECTS
9

Method of grading
numerical grade

Only after succ. compl. of module(s)

Duration
1 semester

Module level
undergraduate

Other prerequisites

Contents
This module introduces students to the rules of aromaticity and discusses specific reactions of aromatics. Using the example of carbonyl compounds, it extends the students’ knowledge of substitution, elimination and addition reactions to complex reaction mechanisms. The course also focuses on oxidation and reduction reactions as well as rearrangement. In addition, it introduces students to the spectroscopic methods of infrared spectroscopy, mass spectrometry and NMR spectroscopy.

Intended learning outcomes
Students have become familiar with the criteria for aromaticity. They can analyse the varying reactivity of carbonyl compounds. They are able to describe specific reactions of carbonyls and aromatics. For that purpose, they can plan and formulate multi-stage syntheses with complex reaction mechanisms and can transfer them to unknown reactions. Students are able to describe important spectroscopic methods, to evaluate a spectrum and to draw conclusions regarding the molecular structure.

Courses (type, number of weekly contact hours, language — if other than German)
V (3) + Ü (1) + V (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)
Language of assessment: German and/or English

Allocation of places

Additional information

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<td>Laboratory Course Physics for Students of Physics Related Disciplines</td>
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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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<tr>
<td>1 semester</td>
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### Contents

Simple experiments in the fields of mechanics, vibration theory, thermodynamics, optics, X-rays, nuclear magnetic resonance, Atomic and Nuclear Physics, imaging methods.

### Intended learning outcomes

The students have detected and understood physical contexts on the basis of the implementation of own experiments. They have a basic understanding of physical phenomena and know the basic ideas and ways of functioning of different measuring and imaging methods as well as their applications, especially in the field of Biomedicine.

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

P (4)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) practical assignment with oral test (approx. 15 minutes, during experiments) and b) written examination (90 minutes).

Each experiment comprises preparation, performance and evaluation. Test as well as performance of experiments can each be repeated once.

### 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>Polymer Chemistry 1 (Lecture and Practical Course)</td>
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<td>holder of the Chair of Functional Materials in Medicine and Dentistry</td>
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<td>1 semester</td>
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**Contents**

Basic methods of polymerisation: free radical polymerisations, polyadditions, ionic polymerisations, controlled radical polymerisations; characterisation of polymers and polymer analytics: gel permeation chromatography, endgroup analysis, mass spectrometry, rheology.

**Intended learning outcomes**

The students acquire fundamentals of polymer chemistry and the related methods for their characterisation.

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

V (2) + P (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) assessment and b) Vortestate/Nachtestate (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical assignments (2 to 4 random examinations)

Assessment offered: Once a year, winter semester
Language of assessment: German and/or English creditable for bonus

**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
General and analytical Chemistry Lab for engineering students

### Abbreviation
08-ACP1-FU-152-m01

### Module coordinator
holder of the Chair of Anorganic Chemistry

### Module offered by
Institute of Inorganic Chemistry

### ECTS
5

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

### Duration
1 semester

### Module level
undergraduate

### Other prerequisites
--

## Contents
The module provides the opportunity to apply the knowledge of the introductory lectures in a practical course. After a safety introduction the students experiment independently in the laboratory. Focuses are laboratory safety, basic laboratory techniques, synthesis of basic compounds and analysis of an unknown compound.

## Intended learning outcomes
The student is able to identify basic chemical issues and to solve them experimentally. Therefor he/she can carry out the necessary stoichiometric calculations and correctly outline the chemical processes written and verbal.

## Courses
(P, 5)

### Method of assessment
Vortestate/Nachtestate (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical performance (2 to 4 random examinations)

Assessment offered: Once a year, summer semester

Language of assessment: German and/or 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)

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## Module title
Physical Chemistry (lab) for engineering students

## Abbreviation
08-PCP-FU-152-m01

### Module coordinator
lecturer of lecture “Thermodynamik, Kinetik, Elektrochemie”

### Module offered by
Institute of Physical and Theoretical Chemistry

### ECTS
5

### Method of grading
(not) successfully completed

### Only after succ. compl. of module(s)
o8-PC-QMS-FU or o8-PC-TKE

### Duration
1 semester

### Module level
undergraduate

### Other prerequisites
--

### Contents
This module gives students the opportunity to apply in practice the knowledge they have gained through the related lecture(s). After a safety briefing, the students autonomously conduct experiments in the laboratory. In addition to those experiments, students will be expected to take oral tests and write lab reports to demonstrate their knowledge.

### Intended learning outcomes
Students are able to connect the theoretical principles of thermodynamics, kinetics, electrochemistry and spectroscopy with practical laboratory experiments. They are able to analyse the resulting measurements.

### Courses (type, number of weekly contact hours, language — if other than German)
P (4)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
Vortestate/Nachtestate (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical performance (2 to 4 random examinations)
Assessment offered: Once a year, summer semester
Language of assessment: German and/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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<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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<td>Students of Funktionswerkstoffe (Functional Materials, Bachelor’s) are recommended to take module 11-P-FR1.</td>
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</table>

**Contents**

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

**Intended learning outcomes**

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

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

P (5)

Module taught in: German or English

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

Preparation of the experiment will be considered successfully completed if a pre-experiment oral test (approx. 15 minutes) is passed. Performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. An experiment log (approx. 8 pages) must be prepared. Each component of the assessment can be repeated once in the respective semester. Only if both components of the assessment have been successfully completed in the same semester will the module component be considered successfully completed.

Assessment offered: Once a year, winter semester

Language of assessment: German and/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>
<td>Applied Spectroscopy 3</td>
<td>08-PS3-152-m01</td>
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<tr>
<td>lecturer of lecture “Praktische Spektroskopie 3”</td>
<td>Institute of Physical and Theoretical Chemistry</td>
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</table>

**Contents**

This module gives students the opportunity to apply their theoretical knowledge of spectroscopic methods in practice and to interpret readings or graphs. We will record and analyse UV-VIS, fluorescence and vibration spectra and discuss modern mass spectrometry methods.

**Intended learning outcomes**

Students are able to work with different spectrometers and to interpret the resulting spectra. They are able to conduct error discussions.

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

V (3)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Language of assessment: German and/or English

**Allocation of places**

--

**Additional information**

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

--
Module title | Programming and numerical methods
---|---
Abbreviation | 08-PKC-152-m01

Module coordinator | lecturer of lecture "Programmierkurs für Chemiker"
Module offered by | Institute of Physical and Theoretical Chemistry

ECTS | 5
Method of grading | Only after succ. compl. of module(s)
(n) successfully completed | --

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

Contents
The module introduces students to the basics of a programming language and gives applications to problems related to chemistry.

Intended learning outcomes
Students are able to describe the fundamentals of the programming language and to apply them to problems in chemistry.

Courses (type, number of weekly contact hours, language — if other than German)
S (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)
Assessment offered: Once a year, summer semester
Language of assessment: German and/or English

Allocation of places
--

Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
# Module Programming course for students of Mathematics and other subjects

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<tbody>
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<td>Programming course for students of Mathematics and other subjects</td>
<td>10-M-PRG-152-m01</td>
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## Module coordinator
Dean of Studies Mathematik (Mathematics)

## Module offered by
Institute of Mathematics

## ECTS
3

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

## Duration
1 semester

## Module level
undergraduate

## Other prerequisites
--

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

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

## Courses
(type, number of weekly contact hours, language — if other than German)
P (2)

## Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
project in the form of programming exercises (approx. 20 to 25 hours)
Assessment offered: Once a year, summer semester
Language of assessment: German and/or English

## Allocation of places
--

## Additional information
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## Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 f)
Module title | Abbreviation
--- | ---
Quantum Chemistry | 08-TC-152-m01

Module coordinator | Module offered by
lecturer of lecture "Quantenchemie" | Institute of Physical and Theoretical Chemistry

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

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

Contents
This module provides students with deeper insights into advanced topics in quantum chemistry. It focuses on spin, the Pauli principle, Slater determinants, the Hartree-Fock method, correlation energy, configuration interaction and excited states, the Born-Oppenheimer approximation and bonding models of H2+.

Intended learning outcomes
Students are able to describe excited states of molecules with the help of key concepts and models.

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)
Language of assessment: German and/or English creditable for bonus

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 1 h)  
§ 22 II Nr. 2 f)  
§ 22 II Nr. 3 f)
## Module title
Physical Technology of Material Synthesis (Lecture and Practical Course)

## Abbreviation
03-FU-TV-152-m01

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>holder of the Chair of Functional Materials in Medicine and Dentistry</td>
<td>Faculty of Medicine</td>
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</table>

### Contents
Theoretical and practical fundamental knowledge of the fabrication and evaluation of composite respectively sandwich materials.

### Intended learning outcomes
Students gain fundamental knowledge about the fabrication and evaluation of composite materials.

### Courses (type, number of weekly contact hours, language — if other than German)
V (2) + P (2)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
a) assessment and b) Vortestate/Nachtestate (pre and post-experiment examination talks approx. 15 minutes each, log approx. 5 to 10 pages each) and assessment of practical assignments (2 to 4 random examinations)

Assessment offered: Once a year, summer semester

Language of assessment: German and/or English creditable for bonus

### 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>
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<tr>
<td>Thermodynamics, Kinetics, Electrochemistry</td>
<td>08-PC-TKE-152-m01</td>
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<tbody>
<tr>
<td>lecturer of lecture &quot;Thermodynamik, Kinetik, Elektrochemie&quot;</td>
<td>Institute of Physical and Theoretical Chemistry</td>
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</table>

**Contents**

This module introduces students to the principles of thermodynamics. It focuses on the laws of thermodynamics, chemical equilibria, ideal and real gasses/solutions/mixed phases and electrochemistry. In addition to thermodynamic processes, it discusses the fundamental principles of kinetics.

**Intended learning outcomes**

Students are able to explain the laws of thermodynamics. They are able to describe thermodynamic aspects of solutions, gases, mixed phases and electrochemical reactions. Students are able to interpret the kinetic aspects of chemical reactions.

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

- \( V (4) + Ü (2) \)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

- a) written examination (approx. 90 to 180 minutes) or
- b) oral examination of one candidate each (20 to 30 minutes) or
- c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or
- d) log (approx. 20 pages) or
- e) presentation (approx. 30 minutes)

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

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

§ 62 I Nr. 1
Courses Related to Functional Materials outside of the Natural Sciences

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<th>Module title</th>
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<td>Courses Related to Functional Materials outside of the Natural Sciences</td>
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<tr>
<td>degree programme coordinator Funktionswerkstoffe (Functional Materials)</td>
<td>Chair of Chemical Technology of Material Synthesis</td>
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<td>Please consult with course advisory service in advance.</td>
</tr>
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</table>

Contents

Education in a field other than the natural sciences with relevance for the study of functional materials

Intended learning outcomes

The students acquire skills in other fields than the natural sciences.

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

Ü (0)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Language of assessment: German and/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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<td>Courses Related to Functional Materials inside of the Natural Sciences</td>
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<td>degree programme coordinator Funktionswerkstoffe (Functional Materials)</td>
<td>Chair of Chemical Technology of Material Synthesis</td>
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</table>

**Contents**

Education in a field within the natural sciences with relevance for the study of functional materials

**Intended learning outcomes**

The students acquire further qualification in the fields of natural science.

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

Ü (0)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

a) written examination (approx. 90 to 180 minutes) or b) oral examination of one candidate each (20 to 30 minutes) or c) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate) or d) log (approx. 20 pages) or e) presentation (approx. 30 minutes)

Language of assessment: German and/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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<tr>
<td>Advanced Laboratory Course of Functional Materials</td>
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**Module coordinator**

degree programme coordinator Funktionswerkstoffe (Functional Materials)

**Module offered by**

Chair of Chemical Technology of Material Synthesis

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</table>

**Contents**

Practical work with the intention of topical and methodological preparation for the bachelor thesis.

**Intended learning outcomes**

The students are familiar with procedures and methods in research.

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

P (3)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)

Talk (approx. 15 minutes)

Language of assessment: German and/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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