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

Examination regulations version: 2009
Responsible: Institute of Mathematics
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Content and Objectives of the Programme

The Bachelor programme in Computational Mathematics is offered by the Department of Mathematics, with a total of currently (SS 2010) 9 chairs.

At the end of this course of study, the students should be familiar with the main branches of mathematics, taught methods of mathematical reasoning and working as well as analytical thinking, abstract concepts and the ability to recognize and construct complex structures and interconnections. In addition, they should also have interdisciplinary knowledge on the borderline between mathematics, computer science, natural science, and engineering.

Through the course these skills which the students acquire provide the basic knowledge required for a consecutive Bachelor-Masters degree. Moreover, they can later familiarize themselves with the many areas of society in which innovative computer-aided mathematical methods can be applied to or be of use. This is supported through the study of an integrated elective application-oriented subject in which the students become familiar with the basic thoughts and techniques of a subject of their choice, either in natural sciences or engineering, where mathematical methods apply.

In the Bachelor study in computational mathematics, the main emphasis is put on basic mathematical knowledge, method knowledge and the development of the mental constructs which are typical for mathematics. The acquisition of special topics in different secondary branches of mathematics is subordinate.

For the Bachelor thesis the student should work on a thematic and temporally closely limited frame in order to carry out a mathematical task, preferably in some application-oriented context, using well-known procedures and scientific criteria under guidance but, to a large extent, independently.

The exam enables the acquisition of a comparable, international degree in the field of mathematics and provides the framework of a consecutive Bachelor-Masters degree as an initial professional qualification which can be used as a mean for entry into the working world or as preparation for a subsequent Masters study. The exam should ascertain whether the candidate overlooks the context of the basics in mathematics and possesses the ability to use the corresponding scientific methods, with regards to mathematics and the selected elective application-oriented subjects.
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:

ASPO2007

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

10-Aug-2009 (2009-62)

15-Mar-2010 (2010-10)

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.
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(88 ECTS credits)
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<th>Module coordinator</th>
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<tr>
<td>Dean of Studies Mathematik</td>
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<td>2</td>
<td>Only after succ. compl. of module(s)</td>
<td>1 semester undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance of courses (as specified at the beginning of the course).</td>
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**Contents**

Fundamental proof methods and questions in mathematics, insight into examples of abstract concepts of mathematics, e. g. by reference to its historical development, approach to axiomatic and deduction.

**Intended learning outcomes**

The student is acquainted with the basic proof methods and techniques in mathematics. He/She is able to perform easy mathematical arguments independently and present them adequately and reasonably in written and oral form.

**Courses**

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

**Method of assessment**

- Project assignments (type and expenditure of time to be specified by the lecturer at the beginning of the course) Assessment offered: once a year, winter semester Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

- 

**Additional information**

- 

**Referred to in LPO I**

- (examination regulations for teaching-degree programmes)
Module title | Numerical Mathematics 1
---|---
Abbreviation | 10-M-NM1-082-m01

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

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<td>8</td>
<td>numerical grade</td>
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Duration | 1 semester
Module level | undergraduate
Other prerequisites | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

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

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

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
Module title: Analysis
Abbreviation: 10-M-ANA-082-m01

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

ECTS: 17
Method of grading: numerical grade
Only after succ. compl. of module(s): --

Duration: 2 semester
Module level: undergraduate
Other prerequisites: By way of exception, additional prerequisites are listed in the section on assessments.

Contents
Real numbers and completeness, basic topological notions, convergence and divergence of sequences and series, power series, Taylor series, fundamental calculus in one and several variables (including inverse and implicit function theorem); fundamental integral calculus in one variable (Riemann integral and improper integrals).

Intended learning outcomes
The student knows and masters the essential methods and notions of analysis. He/She is able to perform easy mathematical arguments and present them adequately in written and oral form. He/She is acquainted with the central proof methods and concepts in analysis, their analytic background and geometric interpretation.

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

- 10-M-ANA-1-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-ANA-2-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-ANA-P-082: M (no information on SWS (weekly contact hours) and course language available)

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

Assessment in module component 10-M-ANA-1-082: Analysis 1
- 8 ECTS, Method of grading: (not) successfully completed
- a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Modules 10-M-VKM and 10-M-PPM are recommended.

Assessment in module component 10-M-ANA-2-082: Analysis 2
- 7 ECTS, Method of grading: (not) successfully completed
- a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Modules 10-M-VKM and 10-M-PPM are recommended; in addition, module component 10-M-ANA-1 is recommended for module component 10-M-ANA-2.

Assessment in module component 10-M-ANA-P-082: Examination in Analysis
- 2 ECTS, Method of grading: numerical grade
- oral examination of one candidate each (approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Only after successful completion of module components: Successful completion of any one of the module components 10-M-ANA-1, 10-M-ANL-1, 10-M-ANA-2, 10-M-ANL-2 is a prerequisite for participation in module component 10-M-ANA-P.
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Referred to in LPO I (examination regulations for teaching-degree programmes)
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### Contents

Sets, relations and maps; notions of groups, rings and fields (in particular, polynomial rings); vector spaces (subspaces, quotient spaces, linear independency, basis, dimension); linear maps (isomorphism theorem, image, kernel, rank); matrix calculus; systems of linear equations, determinants, eigenvalues, eigenvectors and eigenspaces, diagonalisability (including characteristic polynomial, minimal polynomial), normal forms, bilinear forms; Euclidean and unitary vector spaces (orthonormal bases, isometries, principal axis transformation).

### Intended learning outcomes

The student knows and masters the basic notions and essential methods of linear algebra. He/She is able to perform easy mathematical arguments independently, and can present them adequately in written and oral form. He/She is able to apply the central proof methods and concepts of linear algebra and knows about their algebraic and geometric background.

### Courses

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

- 10-M-LNA-1-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-LNA-2-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-LNA-P-082: M (no information on SWS (weekly contact hours) and course language available)

### Method of assessment

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

**Assessment in module component 10-M-LNA-1-082: Linear Algebra 1 Linear Algebra 1**

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

**Assessment in module component 10-M-LNA-2-082: Linear Algebra 2 Linear Algebra 2**

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

**Assessment in module component 10-M-LNA-P-082: Examination in Linear Algebra**

- 2 ECTS, Method of grading: numerical grade
- oral examination of one candidate each (approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Only after successful completion of module components: Successful completion of module component 10-M-LNA-1 or module component 10-M-LNA-2 is a prerequisite for participation in module component 10-M-LNA-P.

**Allocation of places**

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**Additional information**

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

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
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<td>1 semester</td>
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<td>Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.</td>
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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

--

**Additional information**

--

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

§ 73 (1) 5. Mathematik Angewandte Mathematik
Module title | Abbreviation
---|---
Ordinary Differential Equations and Complex Analysis | 10-M-DFT-082-m01

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

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

Duration | Module level | Other prerequisites
---|---|---
2 semester | undergraduate | By way of exception, additional prerequisites are listed in the section on assessments.

Contents
Existence and uniqueness theorems on solutions of ordinary differential equations, solution theorems on systems of linear differential equations, introduction to the problem of systems of nonlinear differential equations, basic notions in the qualitative theory of ordinary differential equations, basic properties of holomorphic functions, meromorphic functions and conformal maps, basic proof methods in differential equations and complex analysis, applications in computer science, physics, engineering science and other fields of mathematics.

Intended learning outcomes
The student is acquainted with the fundamental concepts and methods of the theory of ordinary differential equations and holomorphic functions. He/she is able to interconnect these concepts and realises the advantages of thinking across the borders of different branches in mathematics.

Courses (type, number of weekly contact hours, language — if other than German)
This module comprises 3 module components. Information on courses will be listed separately for each module component.
- 10-M-DFT-1-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-DFT-2-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-DFT-P-082: M (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

Assessment in module component 10-M-DFT-1-082: Ordinary Differential Equations Ordinary Differential Equations
- 4 ECTS, Method of grading: (not) successfully completed
- written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

Assessment in module component 10-M-DFT-2-082: Introduction to Complex Analysis Introduction to Complex Analysis
- 7 ECTS, Method of grading: (not) successfully completed
- written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

**Assessment in module component 10-M-DFT-P-082:** Examination in Ordinary Differential Equations and Complex Analysis

- 2 ECTS, Method of grading: numerical grade
- Oral examination of one candidate each (approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Only after successful completion of module components: Successful completion of module component 10-M-DFT-1 or module component 10-M-DFT-2 is a prerequisite for participation in module component 10-M-DFT-P.

### Allocation of places

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### Additional information

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

§ 73 (1) 1. Mathematik Analysis
Module title | Abbreviation
---|---
Advanced Analysis | 10-M-VAN-082-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 | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

Contents
Lebesgue integral in several variables, including theorems on convergence and Fubini’s theorem, $L^p$-spaces and elementary Fourier theory in $L^2$, Gauss’s theorem.

Intended learning outcomes
The student is acquainted with advanced topics in analysis. Taking the example of the Lesbegue integral, he or she is able to understand the construction of a complex mathematical concept.

Courses (type, number of weekly contact hours, language — if other than German)
Ü + V (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 1. Mathematik Analysis
Module title | Abbreviation
---|---
Geometric Analysis and Partial Differential Equations | 10-M-GAP-092-m01

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

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Duration | Module level | Other prerequisites
---|---|---
2 semester | undergraduate | By way of exception, additional prerequisites are listed in the section on assessments.

Contents
Basics in analysis on manifolds, e.g. submanifolds and calculus of differential forms, Stoke's theorem and its applications in vector calculus and topology, examples of first order partial differential equations, existence and uniqueness theorems, basic equations in mathematical physics, boundary value theorems, maximum principle and Dirichlet problem.

Intended learning outcomes
The student knows and masters the basic notions and essential methods of vector analysis on manifolds and partial differential equations. He/She is able to perform mathematical arguments in this field independently, and can present them adequately in written and oral form. He/She is able to apply the central proof methods and concepts of geometric analysis and partial differential equations and knows about their analytic background.

Courses (type, number of weekly contact hours, language — if other than German)
This module comprises 3 module components. Information on courses will be listed separately for each module component.
- **10-M-GAP-1-092**: V + Ü (no information on SWS (weekly contact hours) and course language available)
- **10-M-GAP-2-092**: V + Ü (no information on SWS (weekly contact hours) and course language available)
- **10-M-GAP-P-092**: M (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 10-M-GAP-1-092**: Geometric Analysis Geometric Analysis
- 7 ECTS, Method of grading: (not) successfully completed
- a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Modules 10-M-ANA and 10-M-LNA are recommended.

**Assessment in module component 10-M-GAP-2-092**: Partial Differential Equations Partial Differential Equations
- 4 ECTS, Method of grading: (not) successfully completed
- a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Modules 10-M-ANA and 10-M-LNA are recommended.

**Assessment in module component 10-M-GAP-P-092**: Examination in Geometric Analysis and Partial Differential Equations
- 2 ECTS, Method of grading: numerical grade
- oral examination of one candidate each (approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Only after successful completion of module components: 10-M-GAP-1 or 10-M-GAP-2
- Other prerequisites: Modules 10-M-ANA and 10-M-LNA are recommended.
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<td>Module title</td>
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<tr>
<td>Modelling and Computational Science</td>
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<th>Duration</th>
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<td>1 semester</td>
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**Contents**


**Intended learning outcomes**

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

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)

**Allocation of places**

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**Additional information**

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

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Compulsory Electives

(62 ECTS credits)
Mathematics 1  
(8-18 ECTS credits)

Students must complete modules worth no less than 8 ECTS credits; however, of the two modules 10-M-EZT and 10-M-ZAL no more than one may be taken.
Module title | Abbreviation
--- | ---
Introduction to Discrete Mathematics | 10-M-EDM-072-m01

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Contents
Techniques from combinatorics, introduction to graph theory (including applications), cryptographic methods, error-correcting codes.

Intended learning outcomes
The student is acquainted with the fundamental concepts and results in discrete mathematics, masters the relevant proof techniques, is able to apply methods from number theory and algebra to discrete mathematics and realises the scope of applications of discrete structures.

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
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<tr>
<td>Introduction to Functional Analysis</td>
<td>10-M-FAN-072-m01</td>
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**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 + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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

§ 73 (1) 1. Mathematik Analysis
Module title | Abbreviation
--- | ---
Operations Research | 10-M-ORS-072-m01

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

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

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

Contents
Linear programming, duality theory, transport problems, integral linear programming, graph theoretic problems.

Intended learning outcomes
The student is acquainted with the fundamental methods in operations research, as required as a central tool for solving many practical problems especially in economics. He/She is able to apply these methods to practical problems, both theoretically and numerically.

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
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<td>Introduction to Number Theory</td>
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**Module coordinator**

Dean of Studies Mathematik (Mathematics)

**Module offered by**

Institute of Mathematics

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**Duration**

1 semester

**Module level**

undergraduate

**Other prerequisites**

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**Contents**

Elementary properties of divisibility, prime numbers and prime number factorisation, modular arithmetics, prime tests and methods for factorisation, structure of the residue class rings, theory of quadratic remainder, quadratic forms, diophantine approximation and diophantine equations.

**Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods of elementary number theory. He/She is able to apply these methods to practical problems, e.g., in cryptography.

**Courses**

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

**Method of assessment**

(a) written examination (90 minutes; usually chosen) or (b) oral examination of one candidate each (20 minutes) or (c) oral examination in groups (groups of 2, 30 minutes)

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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<td>Non-Linear Dynamics</td>
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**Module coordinator**
Dean of Studies Mathematik (Mathematics)

**Module offered by**
Institute of Mathematics

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**Duration**
1 semester

**Module level**
undergraduate

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

**Contents**
Basic notions in stability theory, Lyapunov theory; stable manifolds, periodic solutions including Poincare-Bendixson, chaotic dynamics; applications in physics and biology (e.g. Hamiltonian systems, Volterra-Lotka).

**Intended learning outcomes**
The student is acquainted with the fundamental concepts and results in non-linear dynamics and their proof methods. He/She is able to apply these methods to simple situations, e.g. in physics or biology.

**Courses**
(type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**
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**Additional information**
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**Referred to in LPO I**
(examination regulations for teaching-degree programmes)
§ 73 (1) 1. Mathematik Analysis
Module title
Introduction to Geometry

Abbreviation
10-M-GEO-082-m01

Module coordinator
Dean of Studies Mathematik (Mathematics)

Module offered by
Institute of Mathematics

ECTS
8

Method of grading
numerical grade

Duration
1 semester

Module level
undergraduate

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

Contents
Introduction to topics in geometry: axiomatic introduction of projective spaces, coordinates, fundamental theorems, relations to linear algebra and algebra, curves and hypersurfaces in Euclidean spaces, curvature.

Intended learning outcomes
The student is acquainted with the fundamental concepts and methods of geometry.

Courses
This module has 2 components; information on courses listed separately for each component.

• 10-M-GEO-1-082: V + Ü (no information on language and number of weekly contact hours available)
• 10-M-GEO-2-082: V + Ü (no information on language and number of weekly contact hours available)

Method of assessment
This module has the following 2 assessment components. To pass the module as a whole students must pass one of the two assessment components.

Assessment component to module component 10-M-GEO-1-082: Einführung in die Projektive Geometrie
• 8 ECTS credits, method of grading: numerical grade
• written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
• Language of assessment: English, German if agreed upon with the examiner
• Other prerequisites: Admission prerequisite to assessment: successful completion of approx. 50% of exercises. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

Assessment component to module component 10-M-GEO-2-082: Einführung in die Differentialgeometrie
• 8 ECTS credits, method of grading: numerical grade
• written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
• Language of assessment: English, German if agreed upon with the examiner
• Other prerequisites: Admission prerequisite to assessment: successful completion of approx. 50% of exercises. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
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<td>§ 73 (1) 4. Mathematik Geometrie</td>
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</table>
Module title: Number Theory and Algebra
Abbreviation: 10-M-ZAL-082-m01

Module coordinator:
Dean of Studies Mathematik (Mathematics)

Module offered by:
Institute of Mathematics

ECTS: 13
Method of grading: numerical grade
Duration: 2 semester
Module level: undergraduate

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

Contents:
Introduction to number theory, algebra and their interrelations: basic algebraic structures (groups, rings, fields); discussion of properties of integers and rational numbers (as well as algebraic extensions) with regard to their algebraic structure (residue class rings and finite fields).

Intended learning outcomes:
The student is acquainted with the fundamental concepts and methods of number theory and algebra. He/she is able to interrelate these concepts and realises the advantages of thinking across the borders of different branches in mathematics.

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

- 10-M-ZAL-1-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-ZAL-2-082: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-ZAL-P-082: M (no information on SWS (weekly contact hours) and course language available)

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

Assessment in module component 10-M-ZAL-1-082: Introduction to Number Theory
- 4 ECTS, Method of grading: (not) successfully completed
- written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

Assessment in module component 10-M-ZAL-2-082: Introduction to Algebra
- 7 ECTS, Method of grading: (not) successfully completed
- written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for
the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

**Assessment in module component 10-M-ZAL-P-082:** Examination in Number Theory and Algebra

- 2 ECTS, Method of grading: numerical grade
- oral examination of one candidate each (approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Only after successful completion of module components: Successful completion of module component 10-M-ZAL-1 or module component 10-M-ZAL-2 is a prerequisite for participation in module component 10-M-ZAL-P.

**Allocation of places**

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**Additional information**

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

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
### Module title

**Stochastics 1**

### Abbreviation

10-M-ST1-082-m01

### Module coordinator

Dean of Studies Mathematik (Mathematics)

### Module offered by

Institute of Mathematics

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### Duration | Module level | Other prerequisites

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

### Contents

Combinatorics, Laplace models, selected discrete distributions, elementary measure and integration theory, continuous distributions: normal distribution, random variable, distribution function, product measures and stochastic independence, elementary conditional probability, characteristics of distributions: expected value and variance, limit theorems: law of large numbers, central limit theorem.

### Intended learning outcomes

The student is acquainted with fundamental concepts and methods in stochastics, applies these methods to practical problems and knows about the typical fields of application.

### Courses

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

### Method of assessment

- written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

### Allocation of places

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### Additional information

--

### Referred to in LPO I

(examination regulations for teaching-degree programmes)

§ 73 (1) 3. Mathematik Stochastik
Module title
Stochastics 2

Abbreviation
10-M-ST2-082-m01

Module coordinator
Dean of Studies Mathematik (Mathematics)

Module offered by
Institute of Mathematics

ECTS
5

Method of grading
numerical grade

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

Duration
1 semester

Module level
undergraduate

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

Contents
Elements of data analysis, statistics of data in normal and other distributions, elements of multivariate statistics.

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

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 3. Mathematik Stochastik
Mathematics 2
(4 ECTS credits)
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<td>Reading Course Stochastics</td>
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**Module coordinator**

Dean of Studies Mathematik (Mathematics)

**Module offered by**

Institute of Mathematics

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**Duration**

1 semester

**Module level**

undergraduate

**Other prerequisites**

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**Contents**

Advanced topics in stochastics.

**Intended learning outcomes**

The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

**Courses**

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

**Method of assessment**

(a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

**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 coordinator**
Dean of Studies Mathematik (Mathematics)

**Module offered by**
Institute of Mathematics

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**Contents**
Basics in discrete mathematics.

**Intended learning outcomes**
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

**Courses**
A (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

**Allocation of places**
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**Additional information**
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*Referred to in LPO I* (examination regulations for teaching-degree programmes)
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### Contents
Basics in functional analysis.

### Intended learning outcomes
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

### Courses
(type, number of weekly contact hours, language — if other than German)
A (no information on SWS (weekly contact hours) and course language available)

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

### 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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# Reading Course Operations Research

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### Module coordinator

Dean of Studies Mathematik (Mathematics)

### Module offered by

Institute of Mathematics

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### Contents

Basics in operations research.

### Intended learning outcomes

The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

### Courses

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

### Method of assessment

a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

### Allocation of places

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### Additional information

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### Referred to in LPO I

(examination regulations for teaching-degree programmes)

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**Contents**

Basics in dynamical systems and nonlinear dynamics.

**Intended learning outcomes**

The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

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

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**Contents**
Basics in optimization.

**Intended learning outcomes**
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

**Courses**
A (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

**Allocation of places**
--

**Additional information**
--

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

--
Mathematics 3
(5 ECTS credits)
Module title | Abbreviation
--- | ---
Seminar in Analysis | 10-M-BSA-072-m01

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

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

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

Contents
A selected topic in analysis.

Intended learning outcomes
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

Courses (type, number of weekly contact hours, language — if other than German)
S (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
talk (approx. 60 minutes)
Assessment offered: in the semester in which the course is offered
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 1. Mathematik Analysis
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<tr>
<th><strong>Module title</strong></th>
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<td>Seminar in Linear Algebra</td>
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**Contents**

A selected topic in linear algebra.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — If not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)

Assessment offered: in the semester in which the course is offered

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
Module Catalogue for the Subject
Computational Mathematics
Bachelor’s with 1 major, 180 ECTS credits

Module title | Abbreviation
-------------|-------------
Seminar in Algebra | 10-M-BSE-072-m01

Module coordinator
Dean of Studies Mathematik (Mathematics)

Module offered by
Institute of Mathematics

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

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

Contents
A selected topic in algebra.

Intended learning outcomes
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

Method of assessment
Talk (approx. 60 minutes)
Assessment offered: in the semester in which the course is offered
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
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</table>

**Contents**

A selected topic in geometry or differential geometry.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

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

**Method of assessment**  (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)

Assessment offered: in the semester in which the course is offered

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

--

**Additional information**

--

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

§ 73 (1) 4. Mathematik Geometrie
Module title | Abbreviation
---|---
Seminar in Number Theory | 10-M-BSZ-072-m01

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

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

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

Contents
A selected topic in number theory.

Intended learning outcomes
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

Courses (type, number of weekly contact hours, language — if other than German)
S (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
talk (approx. 60 minutes)
Assessment offered: in the semester in which the course is offered
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
## Seminar in Ordinary Differential Equations

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### Module coordinator
Dean of Studies Mathematik (Mathematics)

### Module offered by
Institute of Mathematics

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### Duration
1 semester

### Contents
A selected topic in the theory of ordinary differential equations.

### Intended learning outcomes
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

### Method of assessment
- Talk (approx. 60 minutes)
- Assessment offered: in the semester in which the course is offered
- Language of assessment: German, English if agreed upon with the examiner

### Allocation of places
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### Additional information
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### Referred to in LPO I
(Examination regulations for teaching-degree programmes)
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**Contents**

A selected topic in complex analysis.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

**Courses**

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**Method of assessment**

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<th>language — if other than German</th>
<th>examination offered — if not every semester, information on whether module is creditable for bonus</th>
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</thead>
<tbody>
<tr>
<td>talk</td>
<td>approx. 60 minutes</td>
<td>German, English if agreed upon with the examiner</td>
<td></td>
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</table>

**Allocation of places**

--

**Additional information**

--

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

§ 73 (1) 1. Mathematik Analysis
### Module title
Seminar in Numerical Mathematics

### Abbreviation
10-M-BSN-072-m01

### Module coordinator
Dean of Studies Mathematik (Mathematics)

### Module offered by
Institute of Mathematics

### ECTS
5

### Method of grading
numerical grade

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

### Duration
1 semester

### Module level
undergraduate

### Other prerequisites
--

### Contents
A selected topic in numerical mathematics.

### Intended learning outcomes
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

### Method of assessment
Talk (approx. 60 minutes)

Assessment offered: in the semester in which the course is offered

Language of assessment: German, English if agreed upon with the examiner

### Allocation of places
--

### Additional information
--

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

§ 73 (1) 5. Mathematik Angewandte Mathematik
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<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Seminar in Stochastics</td>
<td>10-M-BSS-072-m01</td>
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</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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</thead>
<tbody>
<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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<table>
<thead>
<tr>
<th>ECTS</th>
<th>Method of grading</th>
<th>Only after succ. compl. of module(s)</th>
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<tbody>
<tr>
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<td>numerical grade</td>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>--</td>
</tr>
</tbody>
</table>

**Contents**

A selected topic in stochastics.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)

Assessment offered: in the semester in which the course is offered

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

--

**Additional information**

--

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

§ 73 (1) 3. Mathematik Stochastik
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Seminar in Functional Analysis</td>
<td>10-M-BSF-072-m01</td>
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<table>
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<th>Module offered by</th>
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<td>Institute of Mathematics</td>
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<tbody>
<tr>
<td>1 semester</td>
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</table>

### Contents
A selected topic in functional analysis.

### Intended learning outcomes
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

### Method of assessment
(talk (approx. 60 minutes))

### Allocation of places
--

### Additional information
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### Referred to in LPO I
(examination regulations for teaching-degree programmes)
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<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tr>
<td>Seminar in Operation Research</td>
<td>10-M-BSO-072-m01</td>
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<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
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</tbody>
</table>

**Contents**

A selected topic in operations research.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)

**Allocation of places**

--

**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>Seminar in Discrete Mathematics</td>
<td>10-M-BSD-072-m01</td>
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<table>
<thead>
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<th>Module offered by</th>
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<tbody>
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<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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<th>ECTS</th>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>--</td>
</tr>
</tbody>
</table>

**Contents**

A selected topic in discrete mathematics.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)

**Allocation of places**

--

**Additional information**

--

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

--
Application-oriented Subject
(35-45 ECTS credits)

Students must take one of the application-oriented subjects (Biologie (Biology), Chemie (Chemistry), Informatik (Computer Science) and Physik (Physics)) with the specified mandatory courses and/or mandatory electives.
Application-oriented Subject Chemistry

(35 ECTS credits)
Application-oriented Subject Chemistry Compulsory Courses
(26 ECTS credits)
Module title: Introduction to Physics for Students of Non-physics-related Minor Subjects

Abbreviation: 11-EFNF-072-m01

Module coordinator: Managing Director of the Institute of Applied Physics

Module offered by: Faculty of Physics and Astronomy

ECTS: 7

Method of grading: numerical grade

Duration: 2 semester

Module level: undergraduate

Other prerequisites: --

Contents:
Mechanics, vibration theory, thermodynamics, optics, science of electricity, Atomic and Nuclear Physics.

Intended learning outcomes:
The students have knowledge of the principles of Physics.

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

Method of assessment:
written examination (approx. 120 minutes)

Allocation of places:
Only as part of pool of general key skills (ASQ): 10 places. Places will be allocated by lot.

Additional information:
--

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>General Chemistry for Mathematics Majors</td>
<td>08-CM1-072-m01</td>
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<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>lecturer of lecture &quot;Experimental chemie&quot; (Experimental Chemistry)</td>
<td>Institute of Inorganic Chemistry</td>
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<tbody>
<tr>
<td>1 semester</td>
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**Contents**

German contents available but not translated yet.


**Intended learning outcomes**

German intended learning outcomes available but not translated yet.


**Courses**

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

**Method of assessment**

written examination (approx. 60 minutes)

**Allocation of places**

--

**Additional information**

--

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)
<table>
<thead>
<tr>
<th>Module title</th>
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<td>Physical Chemistry 1</td>
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<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>lecturer of lecture &quot;Grundlagen der Quantenmechanik and Spektroskopie&quot; (Principles of Quantum Mechanics and Spectroscopy)</td>
<td>Institute of Physical and Theoretical Chemistry</td>
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<th>Module level</th>
<th>Other prerequisites</th>
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<tbody>
<tr>
<td>1 semester</td>
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<td>Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence).</td>
</tr>
</tbody>
</table>

### Contents

German content available but not translated yet.


### Intended learning outcomes

German intended learning outcomes available but not translated yet.

Die Studierenden sind in der Lage, grundlegende Modelle der Quantenmechanik zu erklären und bei Molekülen anzuwenden. Er/Sie kann unterschiedliche spektroskopische Methoden darstellen. Die Studierenden können die mathematischen Grundlagen der elementaren Grundlagen der Quantenmechanik anwenden.

### Courses

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

### Method of assessment

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

### Allocation of places

--

### Additional information

--

### Referred to in LPO I

(examination regulations for teaching-degree programmes)

--
Module title  
Organic Chemistry 1

Abbreviation  
o8-OC1-092-m01

Module coordinator  
holder of the Professorship of Organic Chemistry

Module offered by  
Institute of Organic Chemistry

ECTS  
5

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

Numerical grade  
--

Duration  
1 semester

Module level  
undergraduate

Other prerequisites  
Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence).

Contents

 Deutsch
Das Modul bietet einen Überblick über die elementaren Grundkenntnisse der organischen Chemie. Dazu wird die Bindungssituation am Kohlenstoff betrachtet und in die Nomenklatur einfacher und mäßig komplexer organischer Verbindungen eingeführt. Es werden Grundlagen der Stereochemie, Substitutions-, Additions- und Eliminierungsreaktionen sowie der Syntheseplanung vermittelt.

Intended learning outcomes

 Deutsch

Courses

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

Method of assessment

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

Allocation of places

 --

Additional information

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Referred to in LPO I

 § 62 (1) 2. Chemie "Organische und Bioorganische Chemie"
Application-oriented Subject Chemistry Compulsory Electives
(9 ECTS credits)
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<td>Organic Chemistry 2</td>
<td>08-OC2-092-m01</td>
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<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**

German contents available but not translated yet.


**Intended learning outcomes**

German intended learning outcomes available but not translated yet.


**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

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

**Allocation of places**

--

**Additional information**

--

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

--
### Module Catalogue for the Subject Computational Mathematics

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

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
<tr>
<td>Theoretical Models in Chemistry</td>
<td>08-TC-092-m01</td>
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</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
</tr>
</thead>
<tbody>
<tr>
<td>lecturer of lecture &quot;Quantenchemie&quot;</td>
<td>Institute of Physical and Theoretical Chemistry</td>
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<th>Module level</th>
<th>Other prerequisites</th>
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<tbody>
<tr>
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<td>Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence).</td>
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</tbody>
</table>

### Contents

German contents available but not translated yet.


### Intended learning outcomes

German intended learning outcomes available but not translated yet.

Die Studierenden sind in der Lage, mit Hilfe grundlegender Konzepte und Modelle angeregte Zustände von Molekülen zu beschreiben.

### Courses

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

### Method of assessment

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

### Allocation of places

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### Additional information

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### Referred to in LPO I

(examination regulations for teaching-degree programmes)

--
**Module title**

Physical and Theoretical Chemistry 3: Symmetry and Quantum Chemistry

**Abbreviation**

08-PC3-092-m01

**Module coordinator**

lecturer of lecture "Quantenchemie"

**Module offered by**

Institute of Physical and Theoretical Chemistry

**ECTS**

6

**Method of grading**

Only after succ. compl. of module(s)

**numerical grade**

--

**Duration**

1 semester

**Module level**

undergraduate

**Other prerequisites**

Admission prerequisite to assessment: successful completion of exercises in the respective classes as specified at the beginning of the course (usually 70% of exercises to be successfully completed) as well as regular attendance of exercises (usually a maximum of 2 incidents of unexcused absence).

**Contents**

This module deals with basics of quantum chemistry and symmetry in chemistry.

**Intended learning outcomes**

German intended learning outcomes available but not translated yet.

Der/Die Studierende verfügt über Kenntnisse der Quantenchemie und der Symmetrie in der Chemie und kann diese gezielt anwenden.

**Courses**

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

**Method of assessment**

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

**Allocation of places**

--

**Additional information**

--

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

--
Application-oriented Subject Computer Science
(35 ECTS credits)

Students are recommended to select one of the following four combinations: (a) 10-I-RAL, 10-I-ST, 10-I-AR, 10-I-RAK, 10-I-RK, (b) 10-I-ADS, 10-I-ST, 10-I-PP, 10-I-SWP, (c) 10-I-ADS, 10-I-ST, 10-I-DB, 10-I-WMS, 10-I-OOP, (d) 10-I-ADS, 10-I-TI, 10-I-LOG, 10-I-GT, 10-I-KT
Application-oriented Subject Computer Science Compulsory Electives
(35 ECTS credits)
## Module Catalogue for the Subject
### Computational Mathematics
#### Bachelor’s with 1 major, 180 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
<tr>
<td>Information transmission</td>
<td>10-I-IÜ-072-m01</td>
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</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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</thead>
<tbody>
<tr>
<td>holder of the Chair of Computer Science III</td>
<td>Institute of Computer Science</td>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</tr>
</tbody>
</table>

### Contents

Introduction to probability calculus, coding theory, coding for fault detection and fault correction, information theory, spectrum and Fourier transform, modulation technique, structure of digital transmission systems, introduction to the structure of computer networks, communication protocols.

### Intended learning outcomes

The students possess a technical, theoretical and practical knowledge of the structure of systems for information transmission, a knowledge that is necessary to understand these systems.

### Courses

<table>
<thead>
<tr>
<th>(type, number of weekly contact hours, language — if other than German)</th>
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</thead>
<tbody>
<tr>
<td>V + Ü (no information on SWS (weekly contact hours) and course language available)</td>
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### Method of assessment

<table>
<thead>
<tr>
<th>(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)</th>
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</thead>
<tbody>
<tr>
<td>written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)</td>
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</tbody>
</table>

### 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
Digital computer systems

### Abbreviation
10-I-RAL-072-m01

### Module coordinator
holder of the Chair of Computer Science V

### Module offered by
Institute of Computer Science

### ECTS
8

### Method of grading
Numerical grade

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

### Duration
1 semester

### Module level
Undergraduate

### Other prerequisites
--

### Contents
Introduction to digital technologies, Boolean algebras, combinatory circuits, synchronous and asynchronous circuits, hardware description languages, structure of a simple processor, machine programming, memory hierarchy.

### Intended learning outcomes
The students possess a knowledge of the fundamentals of digital technologies up to the design and programming of easy microprocessors as well as knowledge for the application of hardware description languages for the design of digital systems.

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

### Method of assessment
Written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)

### Allocation of places
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### Additional information
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### Referred to in LPO I
(examination regulations for teaching-degree programmes)

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**Contents**

Computability, decidability, countability, complexity of calculations, Boolean functions and circuits, finite automata and regular sets, generative grammars, context-free languages, context-sensitive languages.

**Intended learning outcomes**

The students possess fundamental and applicable knowledge in the area of computability, decidability, countability, complexity of calculations, Boolean functions and circuits, finite automata and regular sets, generative grammars, context free languages, context sensitive languages.

**Courses**

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

**Method of assessment**

- written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

- (examination regulations for teaching-degree programmes)
Module title
Algorithm and data structures

Abbreviation
10-I-ADS-072-m01

Module coordinator
Dean of Studies Informatik (Computer Science)

Module offered by
Institute of Computer Science

ECTS
8

Method of grading
numerical grade

Duration
1 semester

Module level
undergraduate

Other prerequisites
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Contents
Design and analysis of algorithms, recursion vs. iteration, sort and search methods, data structures, abstract data types, lists, trees, graphs, basic graph algorithms, programming in Java.

Intended learning outcomes
[Version 1: The students are able to independently design algorithms as well as to precisely describe and analyse them. They are able to apply recursion in algorithms and data structures. The students are familiar with the three basic programming paradigms and are able to apply them in practical programs.] [Version 2: The students are able to independently design algorithms as well as to precisely describe and analyse them. The students are familiar with the basic paradigms of the design of algorithms and are able to apply them in practical programs. The students are able to estimate the run-time behaviour of algorithms and to prove their correctness.]

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

Method of assessment
written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
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**Contents**

Overview of control and automation systems, fundamental principles of control technology, Laplace transformation, transfer function, plant, controller types, basic feedback loop, fundamental principles of control engineering, automata, structure of Petri nets, Petri nets for automation, machine-related structure of processing computation machines, communication between process computers and periphery devices, software for automation systems, process synchronisation, process communication, real-time operating systems, real-time planning.

**Intended learning outcomes**

The students master the fundamentals of automation and control.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (80 minutes)

**Allocation of places**

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**Additional information**

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

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**Module coordinator**
Dean of Studies Informatik (Computer Science)

**Module offered by**
Institute of Computer Science

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**Duration**
1 semester

**Module level**
undergraduate

**Other prerequisites**
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**Contents**
Relational algebra and complex SQL statements; database planning and normal forms; xml data modelling; transaction management.

**Intended learning outcomes**
The students possess a knowledge about database modelling and queries in SQL, transactions as well as easy data modelling in XML.

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

**Method of assessment**
written examination (50 minutes) or oral examination (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

**Allocation of places**
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**Additional information**
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**Contents**

[Version 1: Paths, cycles and components, colouring and matching, transitive hull and irreducible kernel, trees, forests and matroids, depth first search, breadth first search, shortest paths, flows and streams, matchings, network design and routing, planar graphs, graph transformations]  
[Version 2: On the one hand, we handle typical graph problems: we solve round trip problems, calculate maximal flows, find matchings and colourings, work with planar graphs and find out how the ranking algorithm of Google works. On the other hand, we become familiar with new concepts, using the examples of graph problems, for example how we model problems as linear programs or how we show that they are fixed parameter computable.]

**Intended learning outcomes**

[Version 1: The students master the following topics: the most important graph theoretical concepts and algorithms: paths, cycles and components, colourings and matching, transitive hull and irreducible kernel, trees, forests, matroids, depth first search, breadth first search, shortest path, flows and streams, matchings, network design and routing, planar graphs, graph transformations.]  
[Version 2: The students are able to model typical problems of computer science as graph problems. In addition, the participants are able to decide which tool from the lecture helps solve a given graph problem algorithmically. In this course, students learn in detail how to estimate the run time of given graph algorithms.]

**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 is creditable for bonus)

written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)

**Allocation of places**

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**Additional information**

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**Contents**
Complexity measurements and classes, general relationships between space and time classes, memory consumption versus computation time, determinism versus indeterminism, hierarchical theorems, translation methods, P-NP problem, completeness problems, Turing reduction, interactive proof systems.

**Intended learning outcomes**
[Version 1: The students possess a fundamental and applicable knowledge in the areas of complexity measurements and classes, general relationships between space and time classes, memory consumption versus computation time, determinism versus indeterminism, hierarchical theorems, translation methods, P-NP problem, completeness problems, Turing reduction, interactive proof systems.] [Version 2: The students possess a fundamental and applicable knowledge in the areas of complexity measurements and classes, memory consumption versus computation time, determinism versus indeterminism, polynomial time hierarchy, complexity of parallel algorithms and complexity of probabilistic algorithms.]

**Courses** (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)

**Allocation of places**
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**Additional information**
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</table>

**Contents**

Syntax and semantics of propositional logic, equivalence and normal forms, Horn formulas, SAT, resolution, infinite formula sets, syntax and semantics of predicate logic.

**Intended learning outcomes**

The students are proficient in the following areas: syntax and semantics of propositional logic, equivalence and normal forms, Horn formulas, SAT, resolution, infinite formula sets, syntax and semantics of predicate logic.

**Courses**

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

**Method of assessment**

written examination (50 minutes) or oral examination (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

**Allocation of places**

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**Additional information**

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**Contents**

Polymorphism, generic programming, meta programming, web programming, templates, document management.

**Intended learning outcomes**

The students are proficient in the different paradigms of object-oriented programming and have experience in their practical use.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (50 minutes) or oral examination (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

**Allocation of places**

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**Additional information**

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**Contents**

The programming language Java. Independent creation of small to middle-sized, high-quality Java programs.

**Intended learning outcomes**

The students are able to independently develop small to middle-sized, high-quality Java programs.

**Courses**

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

**Method of assessment**

completion of programming exercises (expenditure of time as specified) and final examination: written examination (60 to 90 minutes) or oral examination (one candidate each: 10 to 15 minutes, groups of 2: 20 minutes, groups of 3: 30 minutes)

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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### Contents

Instruction set architectures, command processing through pipelining, statical and dynamic instruction scheduling, caches, vector processors, multi-core processors.

### Intended learning outcomes

The students master the most important techniques to design fast computers as well as their interaction with compilers and operating systems.

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## Module title
**Computer networks and communication systems**

### Abbreviation
10-I-RK-072-m01

## Module coordinator
holder of the Chair of Computer Science III

## Module offered by
Institute of Computer Science

### ECTS: 8

## Method of grading
numerical grade

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

## Module level
undergraduate

## Other prerequisites
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## Contents

## Intended learning outcomes
The students possess an intricate knowledge of the structure of computer networks and communication systems as well as fundamental principles to rate these systems.

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

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)

## Allocation of places
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## Additional information
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**Module coordinator**

Dean of Studies Informatik (Computer Science)  

**Module offered by**

Institute of Computer Science

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**Duration**

1 semester  

**Module level**

undergraduate

**Other prerequisites**

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**Contents**

Object-oriented software development with UML, development of graphical user interfaces, foundations of databases and object-relational mapping, foundations of web programming (HTML, XML), software development processes, unified process, agile software development, project management, quality assurance.

**Intended learning outcomes**

The students possess a fundamental theoretical and practical knowledge on the design and development of software systems, in particular for the web.

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)  

written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)

**Allocation of places**

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**Additional information**

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**Contents**

Completion of a project assignment in groups, problem analysis, creation of requirements specifications, specification of solution components (e.g. UML) and milestones, user manual, programming documentation, presentation and delivery of the runnable software product in a colloquium.

**Intended learning outcomes**

The students possess the practical skills for the design, development and execution of a software project in small teams.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Periodic presentations on project progress with regard to detailing problem specifications, the corresponding solution components (software) and the documentation of these; if project is completed in groups, proof of contributions made by the individual student required; software and project documentation as specified in assignment, final presentation (10 to 15 minutes per group)

**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>Knowledge management systems and data mining</td>
<td>10-I-WMS-072-m01</td>
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<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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</thead>
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<tr>
<td>holder of the Chair of Computer Science VI</td>
<td>Institute of Computer Science</td>
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<th>Module level</th>
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<tr>
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<tr>
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<tbody>
<tr>
<td>[Version 1: Foundations in the following areas: process and product-oriented knowledge management systems, basic knowledge representation and inference (rules, objects, constraints, probabilistic, non-monotonous, temporal closure), problem classes and solution methods (diagnostic, construction, simulation), knowledge acquisition and process models, data mining (data warehouse and OLAP, data preprocessing, data visualisation), learning algorithms with data mining (learning of decidability trees, rules, subgroups, clusters), semantic web.] [Version 2: Foundations in the following areas: process and product-oriented knowledge management systems, basic knowledge representation and inference (rules, objects, constraints, probabilistic, non-monotonous, temporal closure), solution methods (diagnostic, construction), knowledge acquisition and process models, semantic web.]</td>
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<table>
<thead>
<tr>
<th>Intended learning outcomes</th>
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<tbody>
<tr>
<td>The students possess the theoretical and practical knowledge necessary to understand and develop knowledge management systems and data mining systems including knowledge formalisation. The students also have acquired experience in a small project.</td>
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<table>
<thead>
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<th>Courses</th>
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<tbody>
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<td>V + Ü + Ü (no information on SWS (weekly contact hours) and course language available)</td>
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<tr>
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<td>(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)</td>
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<tr>
<td>written examination (80 minutes) or oral examination (one candidate each: 20 minutes, groups of 2: 30 minutes, groups of 3: 40 minutes)</td>
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<table>
<thead>
<tr>
<th>Allocation of places</th>
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<table>
<thead>
<tr>
<th>Additional information</th>
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<tr>
<td>(examination regulations for teaching-degree programmes)</td>
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</table>
Application-oriented Subject Physics
(35-36 ECTS credits)

If consent is obtained from the examination committee, modules 11-ENNF1 and 11-ENNF2 (7 ECTS credits each) may be replaced with modules 11-E1 and 11-E2 (8 ECTS credits each).
Application-oriented Subject Physics Compulsory Courses
(16 ECTS credits)
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Introduction to Physics Part 1 for students of Physics Related Minor Subjects</td>
<td>11-ENNF1-062-m01</td>
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</table>

**Module coordinator**  
Managing Director of the Institute of Applied Physics  
Managing Director of the Institute of Applied Physics  
Faculty of Physics and Astronomy

**ECTS** | **Method of grading** | **Duration** | **Module level** | **Other prerequisites** |
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<tr>
<td>7</td>
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<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**  
Mechanics, vibration theory, thermodynamics.

**Intended learning outcomes**  
The students have basic knowledge of physics for engineering students.

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

**Method of assessment**  
written examination (approx. 120 minutes)

**Allocation of places**  
Only as part of pool of general key skills (ASQ): 20 places. Places will be allocated by lot.

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

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<table>
<thead>
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<tbody>
<tr>
<td>Introduction to Physics Part 2 for students of Physics Related Minor Subjects</td>
<td>11-ENNF2-062-m01</td>
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<tbody>
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</tbody>
</table>

## Contents

Science of electricity, magnetism, optics, Atomic Physics.

## Intended learning outcomes

The students have basic knowledge of physics for engineering students.

## Courses

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

## Method of assessment

written examination (approx. 120 minutes)

## Allocation of places

Only as part of pool of general key skills (ASQ): 20 places. Places will be allocated by lot.

## Additional information

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## Referred to in LPO I

(examination regulations for teaching-degree programmes)

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<table>
<thead>
<tr>
<th>Module title</th>
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<tr>
<td>Measurements and Data Analysis</td>
<td>11-PFR-072-m01</td>
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</table>

### Contents
Types of error, error approximation and propagation, graphs, linear regression, average values and standard deviation, distribution functions, significance tests, writing of lab reports and publications.

### Intended learning outcomes
In this module, the students acquire subject-specific transferable skills. They have knowledge of practical experimental work, error propagation and the principles of statistics.

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

### Method of assessment
written examination (approx. 120 minutes)

### Allocation of places
--

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

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Application-oriented Subject Physics Compulsory Electives 1
(3-4 ECTS credits)
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<td>Physics Laboratory Course for students of Physics Related Minor Subjects</td>
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<tbody>
<tr>
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</tbody>
</table>

**Contents**

Mechanics, vibration theory, thermodynamics, optics, X-rays, nuclear magnetic resonance, Atomic and Nuclear Physics.

**Intended learning outcomes**

The students know the principles of Physics.

**Courses**

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

**Method of assessment**

(a) oral test (approx. 15 minutes) during experiment and (b) ungraded written examination (approx. 90 minutes)

**Allocation of places**

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

**Additional information**

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

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<table>
<thead>
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<th>Module title</th>
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<td>Practical Course</td>
<td>11-PG-IAF-072-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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<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Module 11-PFR recommended.</td>
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</table>

**Contents**
Physical laws of mechanics, thermodynamics, optics, science of electricity, vibration and waves, Atomic and Nuclear Physics and wave optics. Basic measuring methods using computers and storage oscilloscopes.

**Intended learning outcomes**
The students have knowledge and skills of physical measuring instruments and experimental techniques. They are able to independently plan and conduct experiments in cooperation with others, and to document the results in a measurement protocol.

**Courses**
- Beispiele aus Mechanik, Wärmelehre und Elektrik (Examples from Mechanics, Thermodynamics and Electricity, BAM): P (2 weekly contact hours)
- Klassische Physik (Classical Physics, KLP): P (2 weekly contact hours)
- Elektrizitätslehre und Schaltungen (Electricity and Circuits, ELS): P (2 weekly contact hours)
- Wellenoptik (Physical Optics, WOP): P (2 weekly contact hours)
- Atom- und Kernphysik (Atomic and Nuclear Physics, AKP): P (2 weekly contact hours)
- Computer und Messtechnik (Computers and Measurement Technology, CMT): P (2 weekly contact hours)

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

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

To pass this module, students must successfully complete two out of the six courses.

To pass this module, students must attend BAM, KLP or ELS courses prior to attending WOP, AKP or CMT courses.

**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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Application-oriented Subject Physics Compulsory Electives 2
(16 ECTS credits)
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<th>Abbreviation</th>
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<tr>
<td>Experimental Physics 3 (Optics, Quantum Phenomena, Introduction Atomic Physics)</td>
<td>11-E3-072-m01</td>
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<tbody>
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<td>1 semester</td>
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</table>

**Contents**

Physical laws of optics, quantum phenomena, introduction to Atomic Physics.

**Intended learning outcomes**

The students have knowledge of the basic contexts and principles of optics, quantum phenomena and Atomic Physics.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)

**Allocation of places**

--

**Additional information**

--

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

--
### Module title

**Theoretical Physics 1 (Theoretical Mechanics)**  

### Abbreviation

11-T1-072-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

Newtonian mechanics, Lagrangian mechanics, Hamiltonian equation of motion, conservation laws.

### Intended learning outcomes

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

### Courses

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

### Method of assessment

written examination (approx. 120 minutes)

### Allocation of places

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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>Theoretical Physics 2 (Theoretical Electrostatics and Electrodynamics)</td>
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</table>

### Contents
Electrostatics, magnetostatics, Maxwell equations, covariant formulation, electrodynamics and matter.

### Intended learning outcomes
The students have knowledge of the principles of classical electrodynamics and the required calculation methods.

### Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

### Method of assessment (type, scope, language — if other than German, examination offered — If not every semester, information on whether module is creditable for bonus)
written examination (approx. 120 minutes)

### Allocation of places
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### Additional information
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<td>Theoretical Physics 3 (Theoretical Quantum Mechanics)</td>
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</table>

**Contents**

Limits of classical physics, Schrödinger equation, mathematical foundations of quantum mechanics, harmonic oscillator, angular momentum and spin, hydrogen atom, many-particle systems.

**Intended learning outcomes**

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

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — If not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)

**Allocation of places**

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**Additional information**

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<table>
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<td>Theoretical Physics 4 (Theoretical Thermodynamics and Statistics)</td>
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**Contents**

Principles of thermodynamics, fundamental theorems, thermodynamic potentials, principles of statistical mechanics.

**Intended learning outcomes**

The students have knowledge of the principles of thermodynamics and statistical mechanics and the required calculation methods.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)

**Allocation of places**

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**Additional information**

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<table>
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<td>Experimental Physics 5 (Introduction to Solid State Physics)</td>
<td>11-E5-082-m01</td>
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<td>Faculty of Physics and Astronomy</td>
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<tr>
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**Contents**

Physical laws of solids: Bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas)

**Intended learning outcomes**

The students have knowledge of the basic contexts and principles of solids: Bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas)

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — If not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes)

**Allocation of places**

--

**Additional information**

--

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

--
Application-oriented Subject Biology
(35 ECTS credits)

There is a restricted number of places in the application-oriented subject Biologie (Biology). Only those students that have submitted a written application and have obtained prior approval from the subject coordinator (Studienfachverantwortliche(r)) will be able to attend courses offered as part of modules from this application-oriented subject. A decision as to what applicants will be granted approval will be made as follows: applicants will be ranked by lottery and the places offered by the Faculty of Biology in the respective academic year will be allocated according to this ranking. Approval will cover in particular the courses offered as part of modules / module components from the area of mandatory courses. Approval may be withdrawn if students spent two consecutive semesters without completing any modules / module components from the application-oriented subject Biologie (Biology). In the case of students changing degree subjects, approval will become void.
Application-oriented Subject Biology Compulsory Courses
(10 ECTS credits)
Module title | Abbreviation
--- | ---
Genetics, Neurobiology, Behaviour | 07-2A2GNV-072-m01

Module coordinator | Module offered by
--- | ---
Dean of Studies Biologie (Biology) | Faculty of Biology

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

Duration | Module level | Other prerequisites
--- | --- | ---
1 semester | undergraduate | By way of exception, additional prerequisites are listed in the section on assessments.

Contents
Fundamental principles of genetics, neurobiology and behavioural biology.

Intended learning outcomes
[Version 1: Students will understand that there are molecular, cellular and system biological mechanisms and processes involved in animal behaviour and will be able to relate animal behaviour to the molecular and formal bases of inheritance.] [Version 2: Students will understand that there are molecular, cellular and system biological mechanisms and processes involved in animal behaviour and will be able to relate animal behaviour to the molecular and formal bases of inheritance.]

Courses (type, number of weekly contact hours, language — if other than German)
This module comprises 3 module components. Information on courses will be listed separately for each module component.
- 07-2A2GNV-1G-072: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 07-2A2GNV-2N-072: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 07-2A2GNV-3V-072: V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

Assessment in module component 07-2A2GNV-1G-072: Basic Genetics
- 2 ECTS, Method of grading: numerical grade
- written examination (approx. 30 minutes)
- Other prerequisites: Admission prerequisite to assessment: regular attendance of exercises and successful completion of the respective exercises as specified at the beginning of the course.

Assessment in module component 07-2A2GNV-2N-072: Basic Neurobiology
- 2 ECTS, Method of grading: numerical grade
- written examination (approx. 30 minutes)
- Other prerequisites: Admission prerequisite to assessment: regular attendance of exercises and successful completion of the respective exercises as specified at the beginning of the course.

Assessment in module component 07-2A2GNV-3V-072: Behavioural Biology
- 2 ECTS, Method of grading: numerical grade
- written examination (approx. 30 minutes, word problems and/or multiple choice questions)
- Other prerequisites: Admission prerequisite to assessment: regular attendance of exercises and successful completion of the respective exercises as specified at the beginning of the course.

Allocation of places
Only as part of "spezielles Studienangebot": 10 places.

Additional information
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<table>
<thead>
<tr>
<th>Referred to in LPO 1 (examination regulations for teaching-degree programmes)</th>
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<tbody>
<tr>
<td>Module title</td>
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<tr>
<td>Structure and Function of Cells</td>
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**Module coordinator**
holder of the Chair of Plant Physiology and Biophysics

**Module offered by**
Faculty of Biology

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<td>1 semester</td>
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<td>Admission prerequisite to assessment: regular attendance of exercises and successful completion of the respective exercises as specified at the beginning of the course.</td>
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</table>

**Contents**

[Version 1: This module will discuss the cell, the smallest unit of life, starting with its macroscopic structure before moving on to its microscopic structure. It will point out differences and similarities between prokaryotic cells (bacteria, archaeabacteria) and eukaryotic cells (animals, plants).]

[Version 2: The first part of the module will acquaint students with the elementary building blocks of life as well as biological categories. Building on this knowledge, the course will then discuss the cell, the smallest unit of life, starting with its macroscopic structure before moving on to its microscopic structure. It will point out differences and similarities between prokaryotic cells (bacteria, archaeabacteria) and eukaryotic cells (animals, plants).]

**Intended learning outcomes**

Knowledge of the structures of prokaryotic and eukaryotic cells and their (biological) macromolecules. Knowledge of the specific characteristics of the intracellular and extracellular structures of prokaryotes as well as animal and plant cells. Familiarity with the components and functioning of microscopes.

**Courses**

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

**Method of assessment**

written examination (60 minutes)

**Allocation of places**

--

**Additional information**

--

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

--
Application-oriented Subject Biology Compulsory Electives
(25 ECTS credits)

Students must take two out of the following three modules: 07-1A1E, 07-1A1P, 07-1A1T. When taking up their studies, students are highly recommended to consult with the course advisory service Biology that will help them choose appropriate modules from the remaining modules.
### Module title
Bioinformatics

### Abbreviation
07-3A3Bl-072-m01

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<thead>
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<td>Faculty of Biology</td>
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<tr>
<td>1 semester</td>
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</table>

### Contents
Fundamental principles of bioinformatics.

### Intended learning outcomes
Students are proficient in methods for the analysis of DNA and protein databases.

### Courses (type, number of weekly contact hours, language — if other than German)
This module comprises 2 module components. Information on courses will be listed separately for each module component.
- 07-3A3Bl-1B-072: V (no information on SWS (weekly contact hours) and course language available)
- 07-3A3Bl-2B-072: S (no information on SWS (weekly contact hours) and course language available)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

**Assessment in module component 07-3A3Bl-1B-072: Bioinformatics (Lecture)**
- 1 ECTS, Method of grading: numerical grade
- written examination (approx. 20 minutes)

**Assessment in module component 07-3A3Bl-2B-072: Bioinformatics (Seminar)**
- 1 ECTS, Method of grading: (not) successfully completed
- term paper (approx. 5 to 10 pages)

### Allocation of places
Only as part of Biochemistry Master’s: 5 places. Places will be allocated by lot.

### Additional information
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
--
Ecology of plants and animals

Module title: Ecology of plants and animals
Abbreviation: 07-3A3OE-072-m01

Module coordinator: Dean of Studies Biologie (Biology)
Module offered by: Faculty of Biology

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

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

Contents

This module will provide students with an overview of the interactions of plants and animals with their abiotic and biotic environments. The module will focus on the functional adaptation to environmental conditions as well as on the structure and dynamics of populations and ecosystems. Students will be introduced to fundamental model concepts of ecology, will become familiar with examples of research findings and will acquire the fundamental knowledge necessary to develop an understanding of current ecological problems.

Intended learning outcomes

Students are familiar with the fundamental principles of research in the field of ecology and with the most important abiotic and biotic factors that influence the distribution and frequency of occurrence of organisms in their environment. In addition, they understand the scientific relevance ecology has to the assessment of environmental issues.

Courses

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

- 07-3A3OE-1T-072: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 07-3A3OE-2P-072: V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment

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

Assessment in module component 07-3A3OE-1T-072: Ecology of Animals (Lecture and Practice) Ecology of Animals (Lecture and Practice)
- 3 ECTS, Method of grading: numerical grade
- written examination (45 minutes)

Assessment in module component 07-3A3OE-2P-072: Ecology of Plant (Lecture and Practice) Ecology of Plant (Lecture and Practice)
- 3 ECTS, Method of grading: numerical grade
- written examination (60 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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**Contents**

The module will introduce students to the practice of bioinformatics and will cover the following topics: sequence analysis, structure analysis, genome analysis, cellular and metabolic networks as well as gene regulation.

**Intended learning outcomes**

Students are able to use appropriate bioinformatic algorithms to address simple problems as well as to interpret their results.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

log (approx. 10 to 20 pages)

**Allocation of places**

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**Additional information**

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**Contents**

Selected topics in autecology and synecology; experimental design, data collection and analysis in animal ecology.

**Intended learning outcomes**

Students have acquired an advanced knowledge in the area of animal ecology. They are able to design simple ecological lab and field experiments as well as to interpret and present their findings.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (60 minutes)

**Allocation of places**

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**Additional information**

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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

written examination (60 minutes)

**Allocation of places**

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**Additional information**

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**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

(log (approx. 10 to 20 pages)

**Allocation of places**

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**Additional information**

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**Contents**

Neurobiology and methods in neurobiology, using Drosophila as a neurogenetic model system.

**Intended learning outcomes**

Students have acquired an advanced knowledge of the neurobiology of a model organism and are able to apply the relevant methods in neurobiology.

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

log (approx. 10 to 20 pages)

**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>Ecology of populations</td>
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### Contents

More in-depth discussion of the structure and dynamics of human and animal populations; regulation of population density; management.

### Intended learning outcomes

Students are able to interpret the structure and dynamics of populations and metapopulations on the basis of model concepts in population ecology and to apply more advanced methods of quantitative analysis to these.

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

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

- **07-4S1NVO5-1PO-092**: V + Ü (no information on SWS (weekly contact hours) and course language available)
- **07-4S1NVO5-2PO-092**: S (no information on SWS (weekly contact hours) and course language available)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

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

#### Assessment in module component 07-4S1NVO5-1PO-092: Basic Ecology of Populations (Lecture, Practice) Basic Ecology of Populations (Lecture, Practice)

- 4 ECTS, Method of grading: numerical grade
- written examination (45 minutes)

#### Assessment in module component 07-4S1NVO5-2PO-092: Ecology of Populations (Seminar)

- 1 ECTS, Method of grading: (not) successfully completed
- presentation (approx. 20 to 30 minutes)

### Allocation of places

--

### Additional information

--

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

--
Module title: Molecular modelling - From DNA to protein
Abbreviation: 07-4S1PS1-092-m01

Module coordinator: holder of the Chair of Plant Physiology and Biophysics
Module offered by: Faculty of Biology

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

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

Contents:
This module will equip students with advanced knowledge on the structure and function of nucleic acids and proteins as well as on the search for and analysis and modelling of plant macromolecules using databases and specific software.

Intended learning outcomes:
Students have acquired a specialist knowledge of the structure-function relationships of macromolecules and are able to work with relevant databases and software.

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

Method of assessment:
computerised practical examination (4 hours)

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>Specific Bioinformatics II</td>
<td>07-5S2MZ3-092-m01</td>
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**Module coordinator**
holder of the Chair of Bioinformatics

**Module offered by**
Faculty of Biology

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**Duration**
1 semester

**Module level**
undergraduate

**Other prerequisites**
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**Contents**
The module will cover two topics from the area of bioinformatics to be selected from the following list: - sequence analysis, phylogenetics and evolution - gene expression profiling - protein structure analysis - programming for bioinformatics - network analysis

**Intended learning outcomes**
Students have acquired knowledge about general strategies and methods of bioinformatics. They are able to independently perform scientific laboratory work.

**Courses**

| (type, number of weekly contact hours, language — if other than German) |
|---------------------------|-----------------------------|
| V + Ü (no information on SWS (weekly contact hours) and course language available) |

**Method of assessment**

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<tr>
<td>a) written examination (approx. 60 minutes) or b) log (approx. 10 to 20 pages) or c) oral examination of one candidate each (approx. 30 minutes) or d) oral examination in groups (groups of up to 3 candidates, approx. 60 minutes) or e) presentation (approx. 20 to 30 minutes)</td>
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**Allocation of places**
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**Additional information**
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**

This module will address one of the central issues of biology: evolution. Fundamental mechanisms and hypotheses will be discussed and students will be introduced to major phylogenetic reconstruction methods.

**Intended learning outcomes**

Ability to recognise evolution as the driving force behind the phylogeny of species. Familiarity with the concepts of phylogenetic relationships between plants/animals.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (30 minutes)

**Allocation of places**  
--

**Additional information**  
--

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

--
Module title | Abbreviation
---|---
The Animal Kingdom | 07-1A1T-072-m01

Module coordinator | Module offered by
holder of the Professorship of Zoology at the Department of Electronmicroscopy | Faculty of Biology

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

Duration | Module level | Other prerequisites
---|---|---
1 semester | undergraduate | Admission prerequisite to assessment: regular attendance of and participation in exercises as well as successful completion of the respective exercises as specified at the beginning of the course.

Contents
Using the example of animals, students will be introduced to the phylogenetic diversity of eukaryotes. At the level of groups in the animal kingdom, students will acquire the fundamental knowledge necessary to understand the forms and functions of animal organisms, with morphology and cytology being discussed in an evolutionary and ecological context.

Intended learning outcomes
Familiarity with the concepts of phylogenetic relationships between animals. Familiarity with the distinguishing characteristics and major representatives of groups in the animal kingdom. Ability to select those animal organisms that are most suitable for particular scientific issues. Familiarity with the components and functioning of microscopes. Fundamental skills in the interpretation of macroscopic and histologic preparations by light microscopy. Fundamental preparation skills.

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 minutes)

Allocation of places
--

Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
**Module title** | **Abbreviation**  
---|---  
The Plant Kingdom | 07-1A1P-072-m01  

**Module coordinator** | **Module offered by**  
holder of the Chair of Plant Physiology and Biophysics | Faculty of Biology  

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

**Duration** | **Module level** | **Other prerequisites**  
1 semester | undergraduate | Admission prerequisite to assessment: regular attendance of exercises as well as successful completion of the respective exercises.  

**Contents**  
Using the example of plants, students will be introduced to the phylogenetic diversity of eukaryotes. At the level of groups in the plant kingdom, students will acquire the fundamental knowledge necessary to understand the forms and functions of plant organisms, with morphology and cytology being discussed in an evolutionary and ecological context.  

**Intended learning outcomes**  
Familiarity with the concepts of phylogenetic relationships between plants. Familiarity with the distinguishing characteristics and major representatives of groups in the plant kingdom. Ability to select those plant organisms that are most suitable for particular scientific issues. Familiarity with the components and functioning of microscopes. Fundamental skills in the interpretation of macroscopic and histologic preparations by light microscopy. Fundamental preparation skills.  

**Courses** *(type, number of weekly contact hours, language — if other than German)*  
V + Ü (no information on SWS (weekly contact hours) and course language available)  

**Method of assessment** *(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)*  
written examination (approx. 60 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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<tbody>
<tr>
<td>1 semester</td>
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### Contents

Molecular and classical genetics.

### Intended learning outcomes

Students are familiar with the mechanisms of inheritance that are essential for developing an understanding of biology as a whole.

### Courses

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<thead>
<tr>
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### Method of assessment

written examination (30 minutes)

### Allocation of places

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### Additional information

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

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Thesis
(10 ECTS credits)
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Registration for assessment: as specified.</td>
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</table>

**Contents**

Independently researching and writing on a topic in mathematics selected in consultation with the supervisor.

**Intended learning outcomes**

The student is able to work independently on a given mathematical topic and apply the skills and methods obtained during his/her studies in the bachelor programme. He/She can write down the result of his/her work in a suitable form.

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — If not every semester, information on whether module is creditable for bonus)

written thesis

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

--

**Additional information**

--

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

--
Subject-specific Key Skills
(15 ECTS credits)
Key Skills 1 (Compulsory)
(10-15 ECTS credits)

Students must take the following modules: 10-M-VKM and 10-M-BAKC as well as either (10-M-PRG and 10-M-COM) or (10-MPRGk and 10-M-COMg) or (10-M-PRG and 10-M-COMg).
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Computational Mathematics, advanced</td>
<td>10-M-COMg-082-m01</td>
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<td>Admission prerequisite to assessment: regular attendance of exercises (attendance monitored, a maximum of one incident of unexcused absence).</td>
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### 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, 10-M-ANL and 10-M-LNA). Computer-based solution of problems in linear algebra, geometry, analysis, in particular differential and integral calculus; visualisation of functions.

### Intended learning outcomes

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

### Courses

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

### Method of assessment

Project in the form of programming exercises (type and expenditure of time to be specified by the lecturer at the beginning of the course)

Assessment offered: once a year, summer semester

Language of assessment: German, English if agreed upon with the examiner

### Allocation of places

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### Additional information

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

§ 73 (1) 5. Mathematik Angewandte Mathematik
<table>
<thead>
<tr>
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<th>Abbreviation</th>
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<tbody>
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<th>Other prerequisites</th>
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<td>Admission prerequisite to assessment: regular attendance (attendance monitored, a maximum of one incident of unexcused absence).</td>
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**Contents**

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

**Intended learning outcomes**

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

**Courses**

<table>
<thead>
<tr>
<th>(type, number of weekly contact hours, language — if other than German)</th>
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<tr>
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**Method of assessment**

<table>
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<td>Language of assessment: German, English if agreed upon with the examiner</td>
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**Allocation of places**

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**Additional information**

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

§ 73 (1) 5. Mathematik Angewandte Mathematik
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<th><strong>Other prerequisites</strong></th>
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<td>Admission prerequisite to assessment: regular attendance of courses (as specified at the beginning of the course).</td>
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</table>

**Contents**

Introduction to the basic techniques in mathematics; approach to sets, propositions, propositional logic.

**Intended learning outcomes**

The student gets acquainted with the basic working techniques which are prerequisites for the further courses in the Bachelor’s degree study programme.

**Courses**

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

**Method of assessment**

Project assignments (type and expenditure of time to be specified by the lecturer at the beginning of the course)

Assessment offered: once a year, winter semester

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)
<table>
<thead>
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<th>Module title</th>
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<th>Other prerequisites</th>
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<tbody>
<tr>
<td>1 semester</td>
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<td>Admission prerequisite to assessment: regular attendance (attendance monitored, a maximum of one incident of unexcused absence).</td>
</tr>
</tbody>
</table>

### Contents

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

### Intended learning outcomes

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

### Courses

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

### Method of assessment

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

### Allocation of places

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### Additional information

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### Referred to in LPO I

( examination regulations for teaching-degree programmes)

§ 73 (1) 5. Mathematik Angewandte Mathematik
Module title | Abbreviation
---|---
Computeroriented Mathematics | 10-M-COM-o82-m01

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

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

Duration | Module level | Other prerequisites
1 semester | undergraduate | Admission prerequisite to assessment: regular attendance of exercises (attendance monitored, a maximum of one incident of unexcused absence).

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

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

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
project in the form of programming exercises (as specified at the beginning of the course)
Assessment offered: once a year, summer semester
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
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<tbody>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

### Contents
The student prepares a scientific talk on the topic and results of his/her Bachelor's thesis and answers questions on his/her talk.

### Intended learning outcomes
The student is able to prepare a presentation of his/her own scientific work. He/She is able to give a short and concise talk on his/her own scientific work, participate in a scientific debate and question the scientific activities of others.

### Courses
A (no information on SWS (weekly contact hours) and course language available)

### Method of assessment
Talk (approx. 15 minutes) with subsequent discussion (approx. 15 minutes)

### Allocation of places
--

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

--
Key Skills 2 (Elective)
(max. 5 ECTS credits)

Students may not select modules they already took in the area of mandatory electives.
<table>
<thead>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**

A selected topic in analysis.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)

Assessment offered: in the semester in which the course is offered

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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

§ 73 (1) 1. Mathematik Analysis
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**Module coordinator**

Dean of Studies Mathematik (Mathematics)

**Module offered by**

Institute of Mathematics

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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</tbody>
</table>

**Contents**

A selected topic in linear algebra.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)

Assessment offered: in the semester in which the course is offered

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
<table>
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<tbody>
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**Module coordinator**

Dean of Studies Mathematik (Mathematics) | Institute of Mathematics

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

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

**Contents**

A selected topic in algebra.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Talk (approx. 60 minutes)
Assessment offered: in the semester in which the course is offered
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
### Module title
Seminar in Geometry

### Abbreviation
10-M-BSG-072-m01

### Module coordinator
Dean of Studies Mathematik (Mathematics)

### Module offered by
Institute of Mathematics

### ECTS
5

### Method of grading
Numerical grade

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

### Duration
1 semester

### Module level
Undergraduate

### Other prerequisites
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### Contents
A selected topic in geometry or differential geometry.

### Intended learning outcomes
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

### Courses
Type, number of weekly contact hours, language — if other than German
S (no information on SWS (weekly contact hours) and course language available)

### Method of assessment
Type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus
Talk (approx. 60 minutes)
Assessment offered: in the semester in which the course is offered
Language of assessment: German, English if agreed upon with the examiner

### Allocation of places
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### Additional information
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### Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 4. Mathematik Geometrie
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**Module coordinator**  
Dean of Studies Mathematik (Mathematics)  

**Module offered by**  
Institute of Mathematics

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**Duration**  
1 semester  

**Module level**  
undergraduate

**Other prerequisites**  
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**Contents**  
A selected topic in complex analysis.

**Intended learning outcomes**  
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

**Method of assessment**  
talk (approx. 60 minutes)  
Assessment offered: in the semester in which the course is offered  
Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**  
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**Additional information**  
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**Referred to in LPO I**  
(examination regulations for teaching-degree programmes)  
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<td>Seminar in Functional Analysis</td>
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**Module coordinator**

Dean of Studies Mathematik (Mathematics)

**Module offered by**

Institute of Mathematics

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**Contents**

A selected topic in functional analysis.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

**Courses**

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

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

talk (approx. 60 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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**Contents**

A selected topic in discrete mathematics.

**Intended learning outcomes**

The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

talk (approx. 60 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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Dean of Studies Mathematik (Mathematics)

**Module offered by**

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**Duration**

1 semester

**Module level**

undergraduate

**Other prerequisites**

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**Contents**

Techniques from combinatorics, introduction to graph theory (including applications), cryptographic methods, error-correcting codes.

**Intended learning outcomes**

The student is acquainted with the fundamental concepts and results in discrete mathematics, masters the relevant proof techniques, is able to apply methods from number theory and algebra to discrete mathematics and realises the scope of applications of discrete structures.

**Courses**

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

**Method of assessment**

written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
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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 + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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</table>

**Contents**

Linear programming, duality theory, transport problems, integral linear programming, graph theoretic problems.

**Intended learning outcomes**

The student is acquainted with the fundamental methods in operations research, as required as a central tool for solving many practical problems especially in economics. He/She is able to apply these methods to practical problems, both theoretically and numerically.

**Courses**

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

**Method of assessment**

written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

§ 73 (1) 5. Mathematik Angewandte Mathematik
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<td>Introduction to Number Theory</td>
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**Contents**

Elementary properties of divisibility, prime numbers and prime number factorisation, modular arithmetics, prime tests and methods for factorisation, structure of the residue class rings, theory of quadratic remainder, quadratic forms, diophantine approximation and diophantine equations.

**Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods of elementary number theory. He/She is able to apply these methods to practical problems, e.g., in cryptography.

**Courses**

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

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (90 minutes; usually chosen) or b) oral examination of one candidate each (20 minutes) or c) oral examination in groups (groups of 2, 30 minutes)

**Allocation of places**

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**Additional information**

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

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### Module title
Non-Linear Dynamics

### Abbreviation
10-M-NLD-072-m01

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### Contents
Basic notions in stability theory, Lyapunov theory; stable manifolds, periodic solutions including Poincare-Bendixson, chaotic dynamics; applications in physics and biology (e.g. Hamiltonian systems, Volterra-Lotka).

### Intended learning outcomes
The student is acquainted with the fundamental concepts and results in non-linear dynamics and their proof methods. He/She is able to apply these methods to simple situations, e.g. in physics or biology.

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

### Method of assessment
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

### Allocation of places
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### Additional information
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### Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 1. Mathematik Analysis
Module title: Stochastics 2
Abbreviation: 10-M-ST2-082-m01

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

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

Duration: 1 semester
Module level: undergraduate
Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

Contents:
Elements of data analysis, statistics of data in normal and other distributions, elements of multivariate statistics.

Intended learning outcomes:
The student is acquainted with fundamental concepts and methods in statistics, applies these methods to practical problems and knows about the typical fields of application.

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

Method of assessment:
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

Allocation of places:
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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 coordinator**
Dean of Studies Mathematik (Mathematics)

**Module offered by**
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**Contents**
Advanced topics in stochastics.

**Intended learning outcomes**
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

**Courses** (type, number of weekly contact hours, language — if other than German)
A (no information on SWS (weekly contact hours) and course language available)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

**Allocation of places**
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**Additional information**
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
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**Contents**

Basics in discrete mathematics.

**Intended learning outcomes**

The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

**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></td>
</tr>
</tbody>
</table>

**Contents**
Basics in functional analysis.

**Intended learning outcomes**
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

**Courses**
A (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

**Allocation of places**
--

**Additional information**
--

**Referred to in LPO I** (examination regulations for teaching-degree programmes)
--
## Reading Course Operations Research

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
<tr>
<td>Reading Course Operations Research</td>
<td>10-M-RCO-082-m01</td>
</tr>
</tbody>
</table>

### Module coordinator
- Dean of Studies Mathematik (Mathematics)

### Module offered by
- Institute of Mathematics

### ECTS
- 4

### Method of grading
- Numerical grade

### Duration
- 1 semester

### Module level
- Undergraduate

### Other prerequisites
- --

### Contents
- Basics in operations research.

### Intended learning outcomes
- The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

### Courses
- (type, number of weekly contact hours, language — if other than German)
- A (no information on SWS (weekly contact hours) and course language available)

### Method of assessment
- (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
- a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

### Allocation of places
- --

### Additional information
- --

### Referred to in LPO I
- (examination regulations for teaching-degree programmes)
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<table>
<thead>
<tr>
<th>Module title</th>
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</thead>
<tbody>
<tr>
<td>Reading Course Dynamical Systems</td>
<td>10-M-RCY-082-m01</td>
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**Module coordinator**
Dean of Studies Mathematik (Mathematics)

**Module offered by**
Institute of Mathematics

<table>
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<th>ECTS</th>
<th>Method of grading</th>
<th>Only after succ. compl. of module(s)</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>numerical grade</td>
<td>--</td>
</tr>
</tbody>
</table>

**Duration**
1 semester  

**Module level**  
undergraduate

**Other prerequisites**  
--

**Contents**
Basics in dynamical systems and nonlinear dynamics.

**Intended learning outcomes**
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

**Courses**  
(type, number of weekly contact hours, language — if other than German)
A (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**  
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

**Allocation of places**
--

**Additional information**
--

**Referred to in LPO I**  
(examination regulations for teaching-degree programmes)
--
### Module Catalogue for the Subject
Computational Mathematics

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

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
<tr>
<td>Reading Course Optimisation</td>
<td>10-M-RCP-082-m01</td>
</tr>
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<table>
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<tr>
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<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
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<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>--</td>
</tr>
</tbody>
</table>

### Contents

Basics in optimization.

### Intended learning outcomes

The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.

### Courses

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

### Method of assessment

a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)

### Allocation of places

--

### Additional information

--

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

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