Module Catalogue
for the Subject
Mathematics
as vertieft studiertes Fach (studied with a focus on the scientific discipline)
with the degree "Erste Staatsprüfung für das Lehramt an Gymnasien"

Examination regulations version: 2009
Responsible: Institute of Mathematics
Contents

The subject is divided into

Abbreviations used, Conventions, Notes, In accordance with

Scientific Discipline

Compulsory Courses
- Propaedeutics of Mathematics
- Introduction to Geometry
- Number Theory and Algebra
- Numerical Mathematics 1
- Linear Algebra
- Preparatory Course Mathematics
- Ordinary Differential Equations and Complex Analysis
- Analysis for students teaching at a German Gymnasium

Compulsory Electives
- Seminar in Analysis
- Seminar in Linear Algebra
- Seminar in Algebra
- Seminar in Geometry
- Seminar in Number Theory
- Seminar in Ordinary Differential Equations
- Seminar in Complex Analysis
- Seminar in Numerical Mathematics
- Seminar in Stochastics
- Introduction to Discrete Mathematics
- Introduction to Functional Analysis
- Operations Research
- Non-Linear Dynamics
- Computational Mathematics, advanced
- Programming course for students of Mathematics and other subjects, simple
- Stochastics 1
- Numerical Mathematics 2
- Stochastics 2
- Programming course for students of Mathematics and other subjects
- Computeroriented Mathematics
- Advanced Analysis
- Stochastics for students teaching at a German Gymnasium
- Reading Course for students teaching at a German Gymnasium

Teaching
- Didactics of Mathematics: Algebra (German Gymnasium)
- Didactics of Mathematics: Geometry/Calculus (German Gymnasium)

Freier Bereich (general as well as subject-specific electives)

Mathematics
- Computers in Mathematical Teaching
- Didactics of Mathematics: Analytic Geometry/Stochastics (German Gymnasium)
- Advanced Didactics of Mathematics (German Gymnasium)
- Hands-on Mathematics
- E-Learning and Blended Learning in Mathematics at school
- Stochastics in Sekundarstufe I (virtual course)
- Basics in Arithmetic (virtual course)
- Basics in School Geometry (virtual course)
- Mathematics in Class 10 (virtual course)

Thesis
- Thesis in Mathematics (teaching degree at German Gymnasium)
The subject is divided into

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<td>Thesis</td>
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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:

\(LASPO2009\)

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

\(11-Jul-2012\) (2012-79)

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.
Scientific Discipline

(92 ECTS credits)
Compulsory Courses
(76 ECTS credits)
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tr>
<td>Propaedeutics of Mathematics</td>
<td>10-M-PPM-082-m01</td>
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<th>Module coordinator</th>
<th>Module offered by</th>
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<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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<th>ECTS</th>
<th>Method of grading</th>
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<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance of courses (as specified at the beginning of the course).</td>
</tr>
</tbody>
</table>

**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**

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

**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>
</tr>
</thead>
<tbody>
<tr>
<td>project assignments (type and expenditure of time to be specified by the lecturer at the beginning of the course)</td>
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<tr>
<td>Assessment offered: once a year, winter semester</td>
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<tr>
<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)

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<table>
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<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Introduction to Geometry</td>
<td>10-M-GEO-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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<tr>
<td>8</td>
<td>numerical grade</td>
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</table>

**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>Referred to in LPO I (examination regulations for teaching-degree programmes)</td>
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<tr>
<td>§ 73 (1) 4. Mathematik Geometrie</td>
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# Module Catalogue for the Subject Mathematics LA Gymnasien

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<th>Abbreviation</th>
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<tr>
<td>Number Theory and Algebra</td>
<td>10-M-ZAL-082-m01</td>
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<td>Institute of Mathematics</td>
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<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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<tbody>
<tr>
<td>2 semester</td>
<td>undergraduate</td>
<td>By way of exception, additional prerequisites are listed in the section on assessments.</td>
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## 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 (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-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 (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-ZAL-1-082: Introduction to Number Theory 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 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 I (examination regulations for teaching-degree programmes)

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
Module title | Abbreviation
---|---
Numerical Mathematics 1 | 10-M-NM1-082-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)
8 | numerical grade | --

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

Contents

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** | **Abbreviation**
--- | ---
Linear Algebra | 10-M-LNA-082-m01

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

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<th>ECTS</th>
<th>Method of grading</th>
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<tbody>
<tr>
<td>14</td>
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<td>Only after succ. compl. of module(s)</td>
</tr>
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</table>

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

**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** (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-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** (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-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

Additional information

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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<thead>
<tr>
<th>Module title</th>
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<td>Preparatory Course Mathematics</td>
<td>10-M-VKM-082-m01</td>
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<th>Module coordinator</th>
<th>Module offered by</th>
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<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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<th>Method of grading</th>
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<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance of courses (as specified at the beginning of the course).</td>
</tr>
</tbody>
</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 (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 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)

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Module title: Ordinary Differential Equations and Complex Analysis
Abbreviation: 10-M-DFT-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:
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:
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:
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**

**Additional information**

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

§ 73 (1) 1. Mathematik Analysis
### Module Catalogue for the Subject

**Mathematics**

**LA Gymnasien**

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<thead>
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<td>10-M-ANL-092-m01</td>
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<td>Institute of Mathematics</td>
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<tr>
<td>2 semester</td>
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<td>By way of exception, additional prerequisites are listed in the section on assessments.</td>
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</table>

### 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. He/She is able to incorporate these concepts in his/her professional teaching.

### Courses

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

- **10-M-ANA-P-082:** M (no information on SWS (weekly contact hours) and course language available)
- **10-M-ANL-1-092:** V + Ü (no information on SWS (weekly contact hours) and course language available)
- **10-M-ANL-2-092:** V + Ü (no information on SWS (weekly contact hours) and course language available)

### Method of assessment

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

**Assessment in module component 10-M-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.

**Assessment in module component 10-M-ANL-1-092:** Analysis 1 for students teaching at a German Gymnasium

- 6 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-ANL-2-092: Analysis 2 for students teaching at a German Gymnasium

- **9 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.

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<table>
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<th>Additional information</th>
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Compulsory Electives
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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 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)

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

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### Allocation of places

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### Additional information

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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 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)

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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**

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</table>

### 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)

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<td>Seminar in Ordinary Differential Equations</td>
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**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** (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
# Seminar in Complex Analysis

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## Duration

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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

<table>
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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 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

(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)

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</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**

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

§ 73 (1) 3. Mathematik Stochastik
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#### LA Gymnasien

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<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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<th>Method of grading</th>
<th>Only after succ. compl. of module(s)</th>
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<tbody>
<tr>
<td>5</td>
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<table>
<thead>
<tr>
<th>Duration</th>
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<th>Other prerequisites</th>
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<tbody>
<tr>
<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>
</tr>
</tbody>
</table>

### 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)

<table>
<thead>
<tr>
<th>Method of assessment</th>
<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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<td>(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)</td>
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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

§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
### Module title
- **Introduction to Functional Analysis**

### Abbreviation
- 10-M-FAN-072-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)

### 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
- 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
- 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) 1. Mathematik Analysis
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<td>Operations Research</td>
<td>10-M-ORS-072-m01</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**
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
<table>
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<td>Non-Linear Dynamics</td>
<td>10-M-NLD-072-m01</td>
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</table>

### 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 Catalogue for the Subject Mathematics

### Module title
Computational Mathematics, advanced

### Abbreviation
10-M-COMg-082-m01

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

### Module offered by
Institute of Mathematics

### ECTS
4

### Method of grading
(only after successfully completed)

### Duration
1 semester

### Module level
undergraduate

### Other prerequisites
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, 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
\( \text{Ü + V (no information on SWS (weekly contact hours) and course language available)} \)

### Method of assessment
\( \text{Project in the form of programming exercises (type and expenditure of time to be specified by the lecturer at the beginning of the course)} \)

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)

\( \text{§ 73 (1) 5. Mathematik Angewandte Mathematik} \)
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<thead>
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<th>Abbreviation</th>
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<tbody>
<tr>
<td>Programming course for students of Mathematics and other subjects, simple</td>
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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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</table>

**Contents**

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

**Intended learning outcomes**

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

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

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

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

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

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

**Allocation of places**

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**Additional information**

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

§ 73 (1) 5. Mathematik Angewandte Mathematik
Module title  | Abbreviation  
---|---
Stochastics 1  | 10-M-ST1-082-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)
8 | numerical grade  | --

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

Contents
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 (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
Module title: Numerical Mathematics 2

Abbreviation: 10-M-NM2-082-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)

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

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

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

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

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

Allocation of places:
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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: Stochastics 2

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

### Module offered by
Institute of Mathematics

### ECTS | Method of grading | Only after succ. compl. of module(s) |
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</table>

### 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)

§ 73 (1) 3. Mathematik Stochastik
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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** (type, number of weekly contact hours, language — if other than German)
P (no information on SWS (weekly contact hours) and course language available)

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

**Allocation of places**
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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
---|---
Computer-oriented Mathematics | 10-M-COM-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)
---|---|---
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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**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**

(4 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**

(4 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

**Stochastics for students teaching at a German Gymnasium**

### Abbreviation

10-M-STL-092-m01

## Module coordinator

Dean of Studies Mathematik (Mathematics)

## Module offered by

Institute of Mathematics

## ECTS

9

## Method of grading

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

Discrete statistics, in particular stochastic modelling, motivation of conceptualisation and discussion of basic assumptions: basic notions of descriptive statistics, discrete probability spaces, random variables, important discrete distributions, elements of combinatorics, principle of inclusion and exclusion, multistage experiments, conditional probability, stochastic independence, common distributions, expected value and variance, covariance and correlation, waiting time problems, law of the large numbers, central limit theorem, confidence intervals and statistical tests in binomial models, stochastic paradoxes.

## Intended learning outcomes

The student is acquainted with fundamental concepts and methods of stochastics, as required for teaching at German Gymnasium. He/She is able to assess stochastic phenomena correctly and handle the concept of statistical significance.

## 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 (i) 3. Mathematik Stochastik

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LA Gymnasien Mathematics (2009)

JMU Würzburg • generated 24-Aug-2021 • exam. reg.

data record Lehramt Gymnasien Mathematik - 2009
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<thead>
<tr>
<th><strong>Module title</strong></th>
<th><strong>Abbreviation</strong></th>
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<tbody>
<tr>
<td>Reading Course for students teaching at a German Gymnasium</td>
<td>10-M-RCL-092-m01</td>
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<tr>
<th><strong>Module coordinator</strong></th>
<th><strong>Module offered by</strong></th>
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<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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<tbody>
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<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**

Independent study of a defined topic in mathematics with the goal of being able to apply the acquired knowledge in the classroom, e.g. in a school project.

**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)

Talk (approx. 30 minutes) or written elaboration (approx. 5 to 10 pages)

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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Teaching
(10 ECTS credits)
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<th>Module title</th>
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<td>Didactics of Mathematics: Algebra (German Gymnasium)</td>
<td>10-M-D1GY-092-m01</td>
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**Contents**

Discussion of basic topics in mathematics didactics for Gymnasium using the example of algebra (Sekundarstufe I) as well as discussion of possibilities of implementation in the classroom, also including modern technologies.

**Intended learning outcomes**

The student is acquainted with basic mathematical ways of thinking and working techniques (in particular in the field of algebra in Sekundarstufe I) and is able to take into account the students’ perception of mathematical topics, He/She knows important aspects of planning and analysing teaching of mathematics, masters different strategies for teaching and learning and can assess them.

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

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

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

a) written examination (approx. 60 minutes) or b) oral examination of one candidate each (approx. 15 minutes) or c) oral examination in groups (groups of 3, approx. 30 minutes) or d) written elaboration (approx. 5 to 10 pages) or e) project (as specified at the beginning of the course)

**Allocation of places**

--

**Additional information**

--

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

§ 73 (1) 6. Mathematik Didaktik
Didactics of Mathematics: Geometry/Calculus (German Gymnasium)

**Module title**

Didactics of Mathematics: Geometry/Calculus (German Gymnasium)

**Abbreviation**

10-M-D2GY-092-m01

<table>
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</table>

**ECTS**

7

**Method of grading**

Numerical grade

**Duration**

2 semester

**Module level**

Undergraduate

**Other prerequisites**

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**Contents**

Discussion of advanced topics in mathematics didactics for Gymnasium using the examples of geometry (Sekundarstufe I) analysis (Sekundarstufe II) as well as discussion of possibilities of implementation in the classroom, also including modern technologies.

**Intended learning outcomes**

The student is acquainted with mathematical ways of thinking and working techniques (in particular in the fields of geometry in Sekundarstufe I and analysis in sekundarstufe II) and is able to take into account the student's perception of mathematical topics, He/She knows different aspects of planning and analysing teaching of mathematics, masters different strategies for teaching and learning und can assess them.

**Courses**

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

- 10-M-D2GY-P-092: M (no information on SWS (weekly contact hours) and course language available)
- 10-M-D2GY-2-092: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-D2GY-1-092: V + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**

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

**Assessment in module component 10-M-D2GY-P-092:** Didactics of Mathematics: Exam Geometry/Calculus (German Gymnasium)

- 1 ECTS, 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. 40 minutes)
- Only after successful completion of module components: Successful completion of the module components 10-M-D2GY-1 and 10-M-D2GY-2 is a prerequisite for participation in module component 10-M-D2GY-P.

**Assessment in module component 10-M-D2GY-2-092:** Didactics of Mathematics: Calculus (German Gymnasium)

- 2 ECTS, Method of grading: (not) successfully completed
- Exercises: At the beginning of the course, the lecturer will specify the type and scope of exercises to be successfully completed over the course of the semester for the module component to be considered successfully completed.

**Assessment in module component 10-M-D2GY-1-092:** Didactics of Mathematics: Geometry (German Gymnasium)

- 4 ECTS, Method of grading: (not) successfully completed
- Exercises: At the beginning of the course, the lecturer will specify the type and scope of exercises to be successfully completed over the course of the semester for the module component to be considered successfully completed.
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<tr>
<th>Allocation of places</th>
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<tr>
<th>Additional information</th>
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<table>
<thead>
<tr>
<th>Referred to in LPO I (examination regulations for teaching-degree programmes)</th>
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<tr>
<td>§ 73 (1) 6. Mathematik Didaktik</td>
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</tbody>
</table>
Freier Bereich (general as well as subject-specific electives) (0-15 ECTS credits)

Teaching degree students must take modules worth a total of 15 ECTS credits in the area Freier Bereich (general as well as subject-specific electives) (Section 9 LASPO (general academic and examination regulations for teaching-degree programmes)). To achieve the required number of ECTS credits, students may take any modules from the areas below.

Freier Bereich -- interdisciplinary: The interdisciplinary additional offer for a teaching degree can be found in the respective Annex "Ergänzende Bestimmungen für den "Freien Bereich" im Rahmen des Studiums für ein Lehramt".
Mathematics
(ECTS credits)

(Freier Bereich (general as well as subject-specific electives) -- subject specific)
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<td>Computers in Mathematical Teaching</td>
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<td>1 semester</td>
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</table>

**Contents**

Discussion of possible ways to use computers in teaching mathematics as well as discussion of common computer tools.

**Intended learning outcomes**

The student is acquainted with basic possibilities for the employment of computers in the teaching of mathematics, as well as with the potential and limitations of computer tools.

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

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

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

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

Assessment offered: every two years, summer semester

**Allocation of places**

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**Additional information**

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

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<table>
<thead>
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<tbody>
<tr>
<td>Didactics of Mathematics: Analytic Geometry/Stochastics (German Gymnasium)</td>
<td>10-M-D3GY-092-m01</td>
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**Contents**

Discussion of basic topics in mathematics didactics for Gymnasium using the examples of analytic geometry and stochastics (Sekundarstufe I) as well as discussion of possibilities of implementation in the classroom, also including modern technologies.

**Intended learning outcomes**

The student is acquainted with basic mathematical ways of thinking and working techniques (in particular in the fields of analytic geometry and stochastics in Sekundarstufe I) and is able to take into account the students' perception of mathematical topics, He/She knows important aspects of planning and analysing teaching of mathematics, masters different strategies for teaching and learning und can assess them.

**Courses**

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

**Method of assessment**

a) written examination (approx. 60 minutes) or b) oral examination of one candidate each (approx. 15 minutes) or c) oral examination in groups (groups of 3, approx. 30 minutes) or d) written elaboration (approx. 5 to 10 pages) or e) project (as specified at the beginning of the course)

Assessment offered: every two years, summer semester

**Allocation of places**

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**Additional information**

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

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<td>Advanced Didactics of Mathematics (German Gymnasium)</td>
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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)**

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**Duration Module level Other prerequisites**

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**Contents**

Discussion of topics in teaching mathematics in a Gymnasium taking into account different aspects, in particular mathematical foundations, didactic analyses, contemporary discussions in mathematics didactics as well as possible approaches in the classroom.

**Intended learning outcomes**

The student is able to discuss central topics and issues on teaching mathematics in high school (German Gymnasium), considering subject-specific, didactical and methodical aspects.

**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: once a year, summer semester

**Allocation of places**

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**Additional information**

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<td>Hands-on Mathematics</td>
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<td>2 semester</td>
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**Contents**

Elaboration and implementation of a school project on a topic in mathematics, e.g. for project days, school term papers (Facharbeiten), Pluskurse (additional courses for the in-depth study of areas of special interest), workshops. In the theoretical phase, the students formulate the subject-specific and didactic requirements of the topic, search for a suitable topic, elaborate this topic for the project and draw up a project plan. This is done in groups with students providing each other with advice as well as challenging and reflecting on each other’s work. In the practical phase, the students prepare the implementation of the project, implement the project with pupils and afterwards reflect the planning and implementation.

**Intended learning outcomes**

The student is able to select a suitable mathematical topic for a school project and elaborate it. He/She is acquainted with different aspects of project planning and management, and can critically reflect the process.

**Courses**

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

**Method of assessment**

(project and implementation thereof: drawing up a project plan (approx. 10 pages) and practical implementation with pupils (type and expenditure of time to be specified by the lecturer at the beginning of the course)

**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>E-Learning and Blended Learning in Mathematics at school</td>
<td>10-M-DVHB-092-m01</td>
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</tr>
</tbody>
</table>

Contents

In a course offered by Virtuelle Hochschule Bayern (vhb), the student becomes acquainted with and reflects on techniques in e-learning and blended learning for teaching mathematics.

Intended learning outcomes

The student is acquainted with basic methods of e-learning and blended learning in teaching mathematics, as well as their potentials and limitations.

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)

web-based project assignments and tests (length/expenditure of time to be announced at the beginning of the course)

Allocation of places

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Additional information

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<table>
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<td>Stochastics in Sekundarstufe I (virtual course)</td>
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Contents
Revision and consolidation of the fundamental topics in stochastics that are prerequisites for the subject-specific and didactic courses in stochastics.

Intended learning outcomes
The student has basic knowledge of stochastics, as required for the study of mathematics and its didactics. He/She is acquainted with the employment of new technologies for teaching stochastics in school.

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)
web-based project assignments and tests (length/expenditure of time to be announced at the beginning of the course)

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:Basics in Arithmetics (virtual course)  
Abbreviation:10-M-VHBAri-092-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)

3 (not) successfully completed

Duration:  
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. Courses offered online by Virtuelle Hochschule Bayern (vhb) in the field of mathematics are always incorporated into a module with an exercise. The respective modules can be identified by the word virtuell (online) added in brackets. Registration for the exercise must always be made via SB@Home at the beginning of the course. This registration for the exercise will be considered a declaration of will to seek admission to assessment. If the exercise was successfully completed, the lecturer will put the registration for assessment into effect at the end of the course.

Contents

Basic topics on teaching arithmetics in school, e.g. divisibility theory, prime numbers, set theory.

Intended learning outcomes

The student learns basic topics in the teaching of arithmetics and the related mathematical backgrounds and proofs. He/She is acquainted with the employment of new technologies for teaching arithmetic in school.

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)

web-based project assignments and tests (length/expenditure of time to be announced at the beginning of the course)

Allocation of places

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Additional information

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

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Module title | Abbreviation
---|---
Basics in School Geometry (virtual course) | 10-M-VHBGeo-092-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. Courses offered online by Virtuelle Hochschule Bayern (vhb) in the field of mathematics are always incorporated into a module with an exercise. The respective modules can be identified by the word virtuell (online) added in brackets. Registration for the exercise must always be made via SB@Home at the beginning of the course. This registration for the exercise will be considered a declaration of will to seek admission to assessment. If the exercise was successfully completed, the lecturer will put the registration for assessment into effect at the end of the course.

Contents
Revision and consolidation of the fundamental topics in elementary geometry that are prerequisites for the subject-specific and didactic courses (in particular teaching degrees Grundschule, Hauptschule, Realschule) in geometry.

Intended learning outcomes
The student has basic knowledge of school geometry, as required for the study of mathematics and its didactics. He/She is acquainted with the employment of new technologies for teaching geometry in school.

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)
web-based project assignments and tests (length/expenditure of time to be announced at the beginning of the course)

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
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<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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</thead>
<tbody>
<tr>
<td>Mathematics in Class 10 (virtual course)</td>
<td>10-M-VHBM10-092-m01</td>
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</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>Dean of Studies Mathematik (Mathematics)</td>
<td>Institute of Mathematics</td>
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</table>

<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>
<td>3</td>
<td>(not) successfully completed</td>
<td>--</td>
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<tr>
<th>Duration</th>
<th>Module level</th>
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<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew. Courses offered online by Virtuelle Hochschule Bayern (vhb) in the field of mathematics are always incorporated into a module with an exercise. The respective modules can be identified by the word virtuell (online) added in brackets. Registration for the exercise must always be made via SB@Home at the beginning of the course. This registration for the exercise will be considered a declaration of will to seek admission to assessment. If the exercise was successfully completed, the lecturer will put the registration for assessment into effect at the end of the course.</td>
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Contents

Basic topics on teaching mathematics in tenth grade in Hauptschule, Realschule and Gymnasium.

Intended learning outcomes

The student learns basic topics in the teaching of mathematics in tenth form at German Mittelschule and Realschule, as well as the related mathematical backgrounds and proofs. He/She is acquainted with the employment of new technologies for teaching mathematics in tenth form.

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)

web-based project assignments and tests (length/expenditure of time to be announced at the beginning of the course)

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)

Preparation of a written Hausarbeit (thesis) in accordance with the provisions of Section 29 LPO I (examination regulations for teaching-degree programmes) is a prerequisite for teaching degree students to be admitted to the Erste Staatsprüfung (First State Examination). In accordance with the provisions of Section 29 LPO I, students studying for a teaching degree Gymnasium may write this thesis in one of the subjects they selected as vertieft studiertes Fach (subject studied with a focus on the scientific discipline) or in the subject Erziehungswissenschaften (Educational Science). Pursuant to Section 29 Sub-section 1 Sentence 2 LPO I, students may also choose to write an interdisciplinary thesis.
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Thesis in Mathematics (teaching degree at German Gymnasium)</td>
<td>10-M-HMGY-092-m01</td>
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<tbody>
<tr>
<td>10</td>
<td>numerical grade</td>
<td>Where applicable, specific modules/module components as specified by supervisor.</td>
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<th>Module level</th>
<th>Other prerequisites</th>
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<td>1 semester</td>
<td>undergraduate</td>
<td>--</td>
</tr>
</tbody>
</table>

**Contents**

Independently researching and writing on a topic in mathematics or mathematics didactics 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 teaching degree programme. He/She can write down the result of his/her work in a suitable form, incorporating aspects of the didactics of mathematics.

**Courses**

(no courses assigned)

**Method of assessment**

Written thesis (approx. 250 to 300 hours total)

Language of assessment: German, exceptions in accordance with Section 29 Subsection 4 LPO I (examination regulations for teaching degree programmes)

**Allocation of places**

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**Additional information**

Additional information on module duration: 1 to 2 semesters.

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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