Subdivided Module Catalogue
for the Subject
Mathematics
as a minor in a Bachelor’s degree programme
(60 ECTS credits)

Examination regulations version: 2008
Responsible: Institute of Mathematics
Course of Studies - Contents and Objectives

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

At the end of this course of study, the student should be familiar with the basics of mathematics, taught methods of mathematical reasoning and working as well as analytical thinking, abstract concepts and the ability to recognize and construct complex structures and interconnections.

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

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

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

Methods of grading: \texttt{NUM} = numerical grade, \texttt{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: \texttt{A} = thesis, \texttt{LV} = course(s), \texttt{PL} = assessment(s), \texttt{TN} = participants, \texttt{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:

\texttt{ASPO2007}

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

\texttt{19-Mar-2009 (2008-43)}

\texttt{24-Mar-2010 (2010-12)}

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

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Module title</th>
<th>ECTS credits</th>
<th>Method of grading</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Compulsory Courses (34 ECTS credits)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-M-PPM-082-m01</td>
<td>Propaedeutics of Mathematics</td>
<td>2</td>
<td>B/NB</td>
<td>26</td>
</tr>
<tr>
<td>10-M-ANA-082-m01</td>
<td>Analysis</td>
<td>17</td>
<td>NUM</td>
<td>5</td>
</tr>
<tr>
<td>10-M-LNA-082-m01</td>
<td>Linear Algebra</td>
<td>14</td>
<td>NUM</td>
<td>18</td>
</tr>
<tr>
<td>10-M-VKM-082-m01</td>
<td>Preparatory Course Mathematics</td>
<td>1</td>
<td>B/NB</td>
<td>42</td>
</tr>
<tr>
<td><strong>Compulsory Electives (26 ECTS credits)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-M-ODE-082-m01</td>
<td>Ordinary Differential Equations</td>
<td>5</td>
<td>NUM</td>
<td>14</td>
</tr>
<tr>
<td>10-M-BSA-072-m01</td>
<td>Seminar in Analysis</td>
<td>5</td>
<td>NUM</td>
<td>28</td>
</tr>
<tr>
<td>10-M-BSL-072-m01</td>
<td>Seminar in Linear Algebra</td>
<td>5</td>
<td>NUM</td>
<td>34</td>
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<tr>
<td>10-M-BSE-072-m01</td>
<td>Seminar in Algebra</td>
<td>5</td>
<td>NUM</td>
<td>27</td>
</tr>
<tr>
<td>10-M-BSG-072-m01</td>
<td>Seminar in Geometry</td>
<td>5</td>
<td>NUM</td>
<td>32</td>
</tr>
<tr>
<td>10-M-BSZ-072-m01</td>
<td>Seminar in Number Theory</td>
<td>5</td>
<td>NUM</td>
<td>38</td>
</tr>
<tr>
<td>10-M-BSW-072-m01</td>
<td>Seminar in Ordinary Differential Equations</td>
<td>5</td>
<td>NUM</td>
<td>33</td>
</tr>
<tr>
<td>10-M-BSC-072-m01</td>
<td>Seminar in Complex Analysis</td>
<td>5</td>
<td>NUM</td>
<td>31</td>
</tr>
<tr>
<td>10-M-BSN-072-m01</td>
<td>Seminar in Numerical Mathematics</td>
<td>5</td>
<td>NUM</td>
<td>35</td>
</tr>
<tr>
<td>10-M-BSS-072-m01</td>
<td>Seminar in Stochastics</td>
<td>5</td>
<td>NUM</td>
<td>37</td>
</tr>
<tr>
<td>10-M-BSF-072-m01</td>
<td>Seminar in Functional Analysis</td>
<td>5</td>
<td>NUM</td>
<td>30</td>
</tr>
<tr>
<td>10-M-BSO-072-m01</td>
<td>Seminar in Operation Research</td>
<td>5</td>
<td>NUM</td>
<td>36</td>
</tr>
<tr>
<td>10-M-BSD-072-m01</td>
<td>Seminar in Discrete Mathematics</td>
<td>5</td>
<td>NUM</td>
<td>29</td>
</tr>
<tr>
<td>10-M-EDM-072-m01</td>
<td>Introduction to Discrete Mathematics</td>
<td>5</td>
<td>NUM</td>
<td>9</td>
</tr>
<tr>
<td>10-M-FAN-072-m01</td>
<td>Introduction to Functional Analysis</td>
<td>5</td>
<td>NUM</td>
<td>10</td>
</tr>
<tr>
<td>10-M-ORS-072-m01</td>
<td>Operations Research</td>
<td>5</td>
<td>NUM</td>
<td>23</td>
</tr>
<tr>
<td>10-M-EZT-072-m01</td>
<td>Introduction to Number Theory</td>
<td>5</td>
<td>NUM</td>
<td>13</td>
</tr>
<tr>
<td>10-M-NLD-072-m01</td>
<td>Non-Linear Dynamics</td>
<td>5</td>
<td>NUM</td>
<td>20</td>
</tr>
<tr>
<td>10-M-COMg-082-m01</td>
<td>Computational Mathematics, advanced</td>
<td>4</td>
<td>B/NB</td>
<td>8</td>
</tr>
<tr>
<td>10-M-GEO-082-m01</td>
<td>Introduction to Geometry</td>
<td>8</td>
<td>NUM</td>
<td>11</td>
</tr>
<tr>
<td>10-M-PRGk-082-m01</td>
<td>Programming course for students of Mathematics and other subjects, simple</td>
<td>2</td>
<td>B/NB</td>
<td>25</td>
</tr>
<tr>
<td>10-M-ZAL-082-m01</td>
<td>Number Theory and Algebra</td>
<td>13</td>
<td>NUM</td>
<td>43</td>
</tr>
<tr>
<td>10-M-NM1-082-m01</td>
<td>Numerical Mathematics 1</td>
<td>8</td>
<td>NUM</td>
<td>21</td>
</tr>
<tr>
<td>10-M-ST1-082-m01</td>
<td>Stochastics 1</td>
<td>8</td>
<td>NUM</td>
<td>39</td>
</tr>
<tr>
<td>10-M-NM2-082-m01</td>
<td>Numerical Mathematics 2</td>
<td>5</td>
<td>NUM</td>
<td>22</td>
</tr>
<tr>
<td>10-M-ST2-082-m01</td>
<td>Stochastics 2</td>
<td>5</td>
<td>NUM</td>
<td>40</td>
</tr>
<tr>
<td>10-M-PRG-082-m01</td>
<td>Programming course for students of Mathematics and other subjects</td>
<td>3</td>
<td>B/NB</td>
<td>24</td>
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<tr>
<td>10-M-COM-082-m01</td>
<td>Computeroriented Mathematics</td>
<td>3</td>
<td>B/NB</td>
<td>7</td>
</tr>
<tr>
<td>10-M-DFT-082-m01</td>
<td>Ordinary Differential Equations and Complex Analysis</td>
<td>13</td>
<td>NUM</td>
<td>15</td>
</tr>
<tr>
<td>10-M-VAN-082-m01</td>
<td>Advanced Analysis</td>
<td>8</td>
<td>NUM</td>
<td>41</td>
</tr>
<tr>
<td>10-M-RCK-082-m01</td>
<td>Small Reading Course Mathematics</td>
<td>1</td>
<td>B/NB</td>
<td>17</td>
</tr>
</tbody>
</table>
Subdivided Module Catalogue for the Subject Mathematics

Minor in a Bachelor’s degree programme, 60 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis</td>
<td>10-M-ANA-082-m01</td>
</tr>
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</table>

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

**Module offered by**
Institute of Mathematics

**ECTS**
17

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

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

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

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

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

- **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.

**Allocation of places**
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Additional information

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

§ 73 (1) 1. Mathematik Analysis
Module title: Computeroriented Mathematics
Abbreviation: 10-M-COM-082-m01

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

ECTS: 3
Method of grading: Only after succ. compl. of module(s)
Not 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 or 10-M-ANL) and 10-M-LNA). Computer-based solution of problems in linear algebra, geometry, analysis, in particular differential and integral calculus; visualisation of functions.

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

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

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

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computational Mathematics, advanced</td>
<td>10-M-COMg-082-m01</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>ECTS</th>
<th>Method of grading</th>
<th>Only after succ. compl. of module(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>(not) successfully completed</td>
<td>--</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance of exercises (attendance monitored, a maximum of one incident of unexcused absence).</td>
</tr>
</tbody>
</table>

**Contents**

Introduction to modern mathematical software for symbolic computation (e.g. Mathematica or Maple) and numerical computation (e.g. Matlab) to supplement the basic modules in analysis and linear algebra (10-M-ANA, 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)

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

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

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

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
Module title | Introduction to Discrete Mathematics
---|---
Abbreviation | 10-M-EDM-072-m01

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

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

Duration | 1 semester
Module level | undergraduate
Other prerequisites | 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
Techniques from combinatorics, introduction to graph theory (including applications), cryptographic methods, error-correcting codes.

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

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

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

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
Subdivided Module Catalogue for the Subject Mathematics
minor in a Bachelor’s degree programme, 60 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Functional Analysis</td>
<td>10-M-FAN-072-m01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Institute of Mathematics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ECTS</th>
<th>Method of grading</th>
<th>Only after succ. compl. of module(s)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>--</td>
</tr>
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<thead>
<tr>
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<th>Module level</th>
<th>Other prerequisites</th>
</tr>
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<tbody>
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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

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

Intended learning outcomes

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

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

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

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a 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
Subdivided Module Catalogue for the Subject Mathematics
minor in a Bachelor’s degree programme, 60 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Geometry</td>
<td>10-M-GEO-o82-m01</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
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<th>Module level</th>
<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>By way of exception, additional prerequisites are listed in the section on assessments.</td>
</tr>
</tbody>
</table>

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-o82: V + Ü (no information on language and number of weekly contact hours available)
- 10-M-GEO-2-o82: 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-o82: 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-o82: 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.
Allocation of places

Additional information

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

§ 73 (1) 4. Mathematik Geometrie
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Number Theory</td>
<td>10-M-EZT-072-m01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

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

**Contents**

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

**Intended learning outcomes**

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

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

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

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

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

**Allocation of places**

--

**Additional information**

--

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

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

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Ordinary Differential Equations</td>
<td>10-M-ODE-082-m01</td>
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<th>Module offered by</th>
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</tr>
</tbody>
</table>

### Contents

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

### Intended learning outcomes

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

### Courses

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

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

### Method of assessment

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

written examination (approx. 90 minutes); 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)

--
Subdivided Module Catalogue for the Subject Mathematics

minor in a Bachelor’s degree programme, 60 ECTS credits

<table>
<thead>
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<th>Module title</th>
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<tr>
<td>Ordinary Differential Equations and Complex Analysis</td>
<td>10-M-DFT-082-m01</td>
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<tbody>
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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

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

Intended learning outcomes

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

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

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

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

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

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

Assessment in module component 10-M-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
Subdivided Module Catalogue for the Subject Mathematics

minor in a Bachelor's degree programme, 60 ECTS credits

- 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
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<th><strong>Module title</strong></th>
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<td>Small Reading Course Mathematics</td>
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**Module coordinator**
Dean of Studies Mathematik (Mathematics)

**Module offered by**
Institute of Mathematics

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

**Contents**

Independent study of a defined topic in mathematics.

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

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

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

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

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**Module title** | **Abbreviation**  
---|---  
Linear Algebra | 10-M-LNA-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)**  
---|---|---  
14 | numerical grade | --

| **Duration** | **Module level** | **Other prerequisites**  
---|---|---  
2 semester | 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 can be chosen to earn a bonus)

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

#### Assessment in module component 10-M-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 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
<table>
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<th>Abbreviation</th>
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<tbody>
<tr>
<td>Non-Linear Dynamics</td>
<td>10-M-NLD-072-m01</td>
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**Module coordinator**

Dean of Studies Mathematik (Mathematics)  
Institute of Mathematics

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</table>

**Duration**

1 semester  
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**

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

**Intended learning outcomes**

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

**Courses**

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

**Method of assessment**

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

written examination (approx. 90 minutes); 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 | Numerical Mathematics 1
---|---
Abbreviation | 10-M-NM1-082-m01

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

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Duration | 1 semester
Module level | undergraduate

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

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

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

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

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

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
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<td>Numerical Mathematics 2</td>
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</table>

**Contents**

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

**Intended learning outcomes**

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

**Courses**

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

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

**Method of assessment**

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

written examination (approx. 90 minutes); 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
--- | ---
Operations Research | 10-M-ORS-072-m01

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

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

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

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

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

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

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a 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: Programming course for students of Mathematics and other subjects

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<tr>
<td>Programming course for students of Mathematics and other subjects</td>
<td>10-M-PRG-082-m01</td>
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<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: regular attendance (attendance monitored, a maximum of one incident of unexcused absence).</td>
</tr>
</tbody>
</table>

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

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

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

#### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a 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 1 (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
<table>
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<td>Programming course for students of Mathematics and other subjects, simple</td>
<td>10-M-PRGk-082-m01</td>
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<td>undergraduate</td>
<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 can be chosen to earn a bonus)

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

**Allocation of places**
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**Additional information**
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
§ 73 (1) 5. Mathematik Angewandte Mathematik
<table>
<thead>
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<td>Admission prerequisite to assessment: regular attendance of courses (as specified at the beginning of the course).</td>
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</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**

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

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

**Method of assessment**

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

project 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
Seminar in Algebra

### Abbreviation
10-M-BSE-072-m01

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

### Module offered by
Institute of Mathematics

### ECTS
5

### Method of grading
numerical grade

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

### Duration
1 semester

### Module level
undergraduate

### Other prerequisites
--

## Contents
A selected topic in 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 can be chosen to earn a bonus)
talk (approx. 60 minutes)
Assessment offered: in the semester in which the course is offered
Language of assessment: German, English if agreed upon with the examiner

## Allocation of places
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## Additional information
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## Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
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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** (type, number of weekly contact hours, language — if other than German)

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

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

Talk (approx. 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
Module title: Seminar in Discrete Mathematics
Abbreviation: 10-M-BSD-072-m01

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

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

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

Contents:
A selected topic in discrete mathematics.

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

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

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

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

A selected topic in functional analysis.

**Intended learning outcomes**

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

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

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

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

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

- talk (approx. 60 minutes)

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

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

**Allocation of places**

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**Additional information**

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

§ 73 (1) 1. Mathematik Analysis
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### 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 can be chosen to earn a 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 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 can be chosen to earn a bonus)

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

**Allocation of places**

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**Additional information**

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

§ 73 (1) 1. Mathematik Analysis
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**Contents**
A selected topic in linear algebra.

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

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

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

**Allocation of places**
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**Additional information**
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie
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<td>Seminar in Numerical Mathematics</td>
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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 can be chosen to earn a 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) 5. Mathematik Angewandte Mathematik
<table>
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**Contents**

A selected topic in operations research.

**Intended learning outcomes**

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

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

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

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

Talk (approx. 60 minutes)

**Allocation of places**

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**Additional information**

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

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Module title | Abbreviation
---|---
Seminar in Stochastics | 10-M-BSS-072-m01

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

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

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

Contents
A selected topic in 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 can be chosen to earn a 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) 3. Mathematik Stochastik
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<td>Institute of Mathematics</td>
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<tr>
<th>ECTS</th>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</tbody>
</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 can be chosen to earn a bonus)

Talk (approx. 60 minutes)

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

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

**Allocation of places**

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**Additional information**

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

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

**Stochastics 1**

### Abbreviation

10-M-ST1-082-m01

### Module coordinator

Dean of Studies Mathematik (Mathematics)

### Module offered by

Institute of Mathematics

### ECTS

8

### Method of grading

numerical grade

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

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### Duration

1 semester

### Module level

undergraduate

### Other prerequisites

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

### Contents

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

### Intended learning outcomes

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

### Courses

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

### Method of assessment

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

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

### Allocation of places

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### Additional information

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### Referred to in LPO I

( examination regulations for teaching-degree programmes)

§ 73 (1) 3. Mathematik Stochastik
<table>
<thead>
<tr>
<th>Module title</th>
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<td>Stochastics 2</td>
<td>10-M-ST2-082-m01</td>
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**Contents**

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

**Intended learning outcomes**

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

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

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a 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
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<tr>
<th>Module title</th>
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<td>Advanced Analysis</td>
<td>10-M-VAN-082-m01</td>
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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** (type, number of weekly contact hours, language — if other than German)

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

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a 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
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<td>Preparatory Course Mathematics</td>
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<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>
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</table>

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

### Intended learning outcomes
The student gets acquainted with the basic working techniques which are prerequisites for the further courses in the Bachelor's degree study programme.

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

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)
project 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 | Number Theory and Algebra
---|---
Abbreviation | 10-M-ZAL-082-m01

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

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

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

Contents
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 can be chosen to earn a bonus)
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

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

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

**Assessment in module component 10-M-ZAL-P-082:** Examination in Number Theory and Algebra
- 2 ECTS, Method of grading: numerical grade
- oral examination of one candidate each (approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Only after successful completion of module components: Successful completion of module component 10-M-ZAL-1 or module component 10-M-ZAL-2 is a prerequisite for participation in module component 10-M-ZAL-P.

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

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