Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

# Subdivided Module Catalogue

## for the Module studies (Bachelor)

# Mathematics

Examination regulations version: 2019
Responsible: Faculty of Mathematics and Computer Science
Responsible: Institute of Mathematics

# 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:

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

**15-May-2019 (2019-36)**

**27-Jun-2019 (2019-41)**

**14-Nov-2019 (2019-52)**

**22-Jan-2020 (2020-13)**

**06-May-2020 (2020-39)**

**22-Jul-2020 (2020-57)**

**17-Dec-2020 (2020-110)**

**10-Mar-2021 (2021-17)**

**09-Jun-2021 (2021-58)**

**22-Dec-2021 (2021-85)**

**05-Jul-2022 (2022-52)**

**31-Jan-2023 (2022-86)**

**15-Jun-2023 (2023-58)**

**13-Dec-2023 (2023-107)**

**07-Aug-2024 (2024-82)**

**22-Jan-2025 (2025-1)**

**09-Jul-2025 (2025-75)**

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

| Abbreviation | Module title | | Method of grading | page |
|---|---|---|---|---|
| **Summer Term 2019** | | | | |
| 10-M-SEM2-152-m01 | Supplementary Seminar Mathematics | 4 | B/NB | 17 |
| **Winter Term 2019** | | | | |
| 10-M-SEM2-152-m01 | Supplementary Seminar Mathematics | 4 | B/NB | 17 |
| **Summer Term 2020** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| **Winter Term 2020** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| **Summer Term 2021** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| 10-M-SEM2-152-m01 | Supplementary Seminar Mathematics | 4 | B/NB | 17 |
| **Winter Term 2021** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-FAN-152-m01 | Introduction to Functional Analysis | 9 | B/NB | 11 |
| 10-M-FANP-152-m01 | Introduction to Functional Analysis for Mathematical Physics | 10 | NUM | 12 |
| 10-M-ZTH-152-m01 | Introduction to Number Theory | 9 | B/NB | 21 |
| 10-M-ZTHP-152-m01 | Introduction to Number Theory for Mathematical Physics | 10 | NUM | 22 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| 10-M-SEM2-152-m01 | Supplementary Seminar Mathematics | 4 | B/NB | 17 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| 10-M-SEM-152-m01 | Seminar Mathematics | 5 | NUM | 16 |
| **Summer Term 2022** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |

| | | | | |
|---|---|---|---|---|
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| **Winter Term 2022** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| 10-M-SEM2-152-m01 | Supplementary Seminar Mathematics | 4 | B/NB | 17 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| 10-M-SEM-152-m01 | Seminar Mathematics | 5 | NUM | 16 |
| **Summer Term 2023** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ANA2-152-m01 | Analysis 2 | 8 | B/NB | 8 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| 10-M-LNA2-152-m01 | Linear Algebra 2 | 8 | B/NB | 15 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| **Winter Term 2023** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ANA2-152-m01 | Analysis 2 | 8 | B/NB | 8 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| 10-M-DGL-152-m01 | Ordinary Differential Equations | 9 | B/NB | 10 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| 10-M-LNA2-152-m01 | Linear Algebra 2 | 8 | B/NB | 15 |
| 10-M-VAN-152-m01 | Advanced Analysis | 7 | NUM | 18 |
| **Summer Term 2024** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ANA2-152-m01 | Analysis 2 | 8 | B/NB | 8 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| 10-M-LNA2-152-m01 | Linear Algebra 2 | 8 | B/NB | 15 |
| **Winter Term 2024** | | | | |
| 10-M-ANA1-152-m01 | Analysis 1 | 8 | B/NB | 7 |
| 10-M-ANA2-152-m01 | Analysis 2 | 8 | B/NB | 8 |
| 10-M-ASM-152-m01 | Reasoning and Writing in Mathematics | 2 | B/NB | 9 |
| 10-M-VHB1-152-m01 | E-Learning and Blended Learning Mathematics 1 | 2 | B/NB | 19 |
| 10-M-VHB2-152-m01 | E-Learning and Blended Learning Mathematics 2 | 2 | B/NB | 20 |

| | | | | |
|---|---|---|---|---|
| 10-M-DGL-152-m01 | Ordinary Differential Equations | 9 | B/NB | 10 |
| 10-M-GBM-152-m01 | Basic Notions and Methods of Mathematical Reasoning | 2 | B/NB | 13 |
| 10-M-LNA1-152-m01 | Linear Algebra 1 | 8 | B/NB | 14 |
| 10-M-LNA2-152-m01 | Linear Algebra 2 | 8 | B/NB | 15 |
| 10-M-VAN-152-m01 | Advanced Analysis | 7 | NUM | 18 |

| Module title | | | Abbreviation |
|---|---|---|---|
| **Analysis 1** | | | 10-M-ANA1-152-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 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Real numbers and completeness; basic topological notions; convergence and divergence of sequences and series; power series and Taylor series; basics in differential calculus in one variable; basics of integral calculus in one variable (Riemann integral and improper integral).

**Intended learning outcomes**

The student knows and masters the essential methods and notions of analysis. He/She is acquainted with the central proof methods in analysis and can employ them to solve easy problems. He/she is able to perform easy mathematical arguments independently and to express mathematical arguments precisely and clearly in written form.

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

V (4) + Ü (2)

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

written examination (approx. 90 to 180 minutes) and written exercises (approx. 12 exercise sheets with approx. 4 exercises each)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Workload**

240 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Analysis 2** | | | 10-M-ANA2-152-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 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Further topological considerations, basics in differential calculus in several variables, inverse function theorem, implicit function theorem.

**Intended learning outcomes**

The student knows and masters the essential methods and notions of analysis. He/She is acquainted with the central proof methods in analysis and can employ them to solve easy problems. He/she is able to perform easy mathematical arguments independently and to express mathematical arguments precisely and clearly in written form.

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

V (4) + Ü (2)

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

written examination (approx. 90 to 180 minutes) and written exercises (approx. 12 exercise sheets with approx. 4 exercises each)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Workload**

240 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Reasoning and Writing in Mathematics** | | | 10-M-ASM-152-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)** | |
| 2 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Introduction to fundamental methods of thinking and proving, basic techniques in mathematics as well as mathematical writing;insight into examples of abstracts concepts in mathematics; 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 (1) + Ü (1)

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

project (10 to 20 pages)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Workload**

60 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Ordinary Differential Equations** | | | 10-M-DGL-152-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)** | |
| 9 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

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

**Intended learning outcomes**

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

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

V (4) + Ü (2)

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

a) written examination (approx. 90 to 180 minutes, usually chosen) or
b) oral examination of one candidate each (15 to 30 minutes) or
c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

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**Workload**

270 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Functional Analysis** | | | 10-M-FAN-152-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)** | |
| 9 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

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

**Intended learning outcomes**

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

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

V (4) + Ü (2)

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

a) written examination (approx. 90 to 180 minutes, usually chosen) or
b) oral examination of one candidate each (15 to 30 minutes) or
c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

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**Workload**

270 h

**Teaching cycle**

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

§ 22 II Nr. 3 f)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Functional Analysis for Mathematical Physics** | | | 10-M-FANP-152-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)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

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

**Intended learning outcomes**

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

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

V (4) + Ü (2)

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

a) oral examination of one candidate each (15 to 30 minutes) or
b) oral examination in groups of 2 candidates (10 to 15 minutes each)
Assessment will have reference to a topic in pure mathematics as agreed upon with the examiner. Each topic may only be selected as the subject of one examination in the sub-field Gesamtüberblick Mathematische Methoden (Overview Mathematical Methods) or in module group Ergänzung Mathematik (Supplementary Topics in Mathematics).
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

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**Workload**

300 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Basic Notions and Methods of Mathematical Reasoning** | | | 10-M-GBM-152-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)** | |
| 2 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Introduction to the basic notions and proof techniques in mathematics: approach to sets, formal logic and maps.

**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 (1) + Ü (1)

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

project (10 to 15 pages)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

Additional information on module duration: block taught prior to the beginning of the lecture period.

**Workload**

60 h

**Teaching cycle**

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

§ 22 II Nr. 1 h)
§ 22 II Nr. 2 f)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Linear Algebra 1** | | | 10-M-LNA1-152-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 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Basic notions and structures; vector spaces, linear maps, systems of linear equations; theory of matrices and determinants.

**Intended learning outcomes**

The student knows and masters the basic notions and essential methods of linear algebra. He/She is acquainted with the central proof methods in linear algebra and can apply them to solve easy problems. He/She is able to perform simple mathematical arguments independently, and can present them adequately in written form.

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

V (4) + Ü (2)

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

written examination (approx. 90 to 180 minutes) and written exercises (approx. 12 exercise sheets with approx. 4 exercises each)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Workload**

240 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Linear Algebra 2** | | | 10-M-LNA2-152-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 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Eigenvalue theory, bilinear forms, Euclidean and unitary vector spaces, diagonalisation and Jordan normal form.

**Intended learning outcomes**

The student knows and masters the basic notions and essential methods of linear algebra. He/She is acquainted with the central proof methods in linear algebra and can apply them to solve easy problems. He/She is able to perform simple mathematical arguments independently, and can present them adequately in written form.

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

V (4) + Ü (2)

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

written examination (approx. 90 to 180 minutes) and written exercises (approx. 12 exercise sheets with approx. 4 exercises each)
Language of assessment: German and/or English

**Allocation of places**

--

**Additional information**

--

**Workload**

240 h

**Teaching cycle**

--

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Seminar Mathematics** | | | 10-M-SEM-152-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 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 (2)

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

talk (60 to 120 minutes)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Workload**

150 h

**Teaching cycle**

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

§ 22 II Nr. 3 f)

| Module title | | | Abbreviation |
|---|---|---|---|
| **Supplementary Seminar Mathematics** | | | 10-M-SEM2-152-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)** | |
| 4 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

A selected topic in 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 (2)

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

talk (60 to 120 minutes)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Workload**

120 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Advanced Analysis** | | | 10-M-VAN-152-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)** | |
| 7 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Continuation of analysis in several variables, integration theorems.

**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)

V (4) + Ü (2)

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

a) written examination (approx. 90 to 180 minutes, usually chosen) or
b) oral examination of one candidate each (15 to 30 minutes) or
c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

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**Workload**

210 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **E-Learning and Blended Learning Mathematics 1** | | | 10-M-VHB1-152-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)** | |
| 2 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Becoming familiar with and reflecting techniques in e-learning and blended learning in mathematics.

**Intended learning outcomes**

The student is able to employ basic methods of e-learning and blended learning in mathematics-

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

Ü (2)
Course type: eLearning, mostly Virtuelle Hochschule Bayern (vhb)

**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 (web-based, 15 to 20 hours)
Assessment offered: Once a year, winter semester

**Allocation of places**

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**Additional information**

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**Workload**

60 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **E-Learning and Blended Learning Mathematics 2** | | | 10-M-VHB2-152-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)** | |
| 2 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**Contents**

Becoming familiar with and reflecting techniques in e-learning and blended learning in mathematics.

**Intended learning outcomes**

The student is able to employ advanced methods of e-learning and blended learning in mathematics-

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

Ü (2)
Course type: eLearning, mostly Virtuelle Hochschule Bayern (vhb)

**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 (web-based, 15 to 20 hours)
Assessment offered: Once a year, summer semester

**Allocation of places**

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**Additional information**

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**Workload**

60 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Number Theory** | | | 10-M-ZTH-152-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)** | |
| 9 | (not) successfully completed | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**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 number theory. He/she is able to employ the basic methods and proof techniques independently.

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

V (4) + Ü (2)

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

a) written examination (approx. 90 to 180 minutes, usually chosen) or
b) oral examination of one candidate each (15 to 30 minutes) or
c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

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**Workload**

270 h

**Teaching cycle**

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

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| Module title | | | Abbreviation |
|---|---|---|---|
| **Introduction to Number Theory for Mathematical Physics** | | | 10-M-ZTHP-152-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)** | |
| 10 | numerical grade | -- | |
| **Duration** | **Module level** | **Other prerequisites** | |
| 1 semester | undergraduate | -- | |

**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 number theory. He/she is able to employ the basic methods and proof techniques independently.

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

V (4) + Ü (2)

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

a) written examination (approx. 90 to 180 minutes, usually chosen) or
b) oral examination of one candidate each (15 to 30 minutes) or
c) oral examination in groups (groups of 2, 10 to 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

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**Workload**

300 h

**Teaching cycle**

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

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