

# Subdivided Module Catalogue for the Subject

# **Mathematics International**

as a Master's with 1 major with the degree "Master of Science" (120 ECTS credits)

Examination regulations version: 2015 Responsible: Faculty of Mathematics and Computer Science Responsible: Institute of Mathematics



## **Learning Outcomes**

#### Scientific qualification

- Graduates are trained in analytical thinking, possess a highly developed capacity for abstraction, universally applicable problem-solving skills and the ability to structure complex relationships.
- Graduates are able to independently familiarise themselves with current research areas in mathematics using specialised literature.
- Graduates are able to present their knowledge, ideas and solutions to complex issues in English to an international audience of experts in a comprehensible way.
- Graduates possess the specialised knowledge, thought processes and methodological skills required for independent scientific work, in particular for doctoral studies.
- Graduates know the rules of good scientific practice and are able to observe them in extensive work
- Graduates have advanced knowledge of current areas of mathematics and are able to confidently use advanced methods in these areas.
- Graduates have in-depth knowledge and an overview of a current research topic from at least one area of mathematics.

#### Ability to take up employment

- Graduates are trained in analytical thinking, possess a highly developed capacity for abstraction, universally applicable problem-solving skills and the ability to structure complex relationships.
- Graduates are able to formulate and present their knowledge, ideas and problem solutions in English in a way that is understandable to the target audience.
- Graduates are able to recognise, structure and model complex problems from other fields (such
  as the natural sciences, engineering or economics), develop solutions using mathematical methods and interpret and evaluate these results.
- The graduates have resilience in solving complex problems.
- The graduates are able to work constructively and oriented towards a goal in international teams and are able to take responsibility for a wide range of tasks.
- Graduates are able to develop new fields of knowledge independently, efficiently and systematically.

#### Personal development

- Graduates are trained in analytical thinking, possess a highly developed capacity for abstraction, universally applicable problem-solving skills and the ability to structure complex relationships.
- Graduates can play a constructive role in participatory processes.
- The graduates have resilience in solving complex problems.
- Graduates are able to formulate complex ideas and proposed solutions in a generally understandable way and present them professionally.
- Graduates possess intercultural skills and can communicate and act in an international environment.



### **Abbreviations used**

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

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:

#### ASP02015

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

#### 13-Jul-2015 (2015-17)

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	ECTS credits	Method of grading	page				
Compulsory Electives (90 I	ECTS credits)	L						
Mathematics (30-70 ECTS credits)								
	Applied Analysis	10	NUM	6				
10-M=AALGin-152-m01								
10-M=ADGMin-152-m01		10	NUM	7 8				
10-M=AFTHin-152-m01	Complex Analysis	10	NUM	10				
10-M=AGMSin-152-m01	Geometric Structures	10	NUM	11				
10-M=AISTin-152-m01	Industrial Statistics 1	10	NUM	13				
10-M=ALTHin-152-m01	Lie Theory	10	NUM	14				
10-M=ANGGin-152-m01	Numeric of Large Systems of Equations	10	NUM	15				
	Basics in Optimization	10	NUM	16				
10-M=ARTHin-152-m01	Control Theory	10	NUM	17				
	Stochastic Models of Risk Management	10	NUM	18				
10-M=ASTPin-152-m01	Stochastical Processes	10	NUM	19				
10-M=ATOPin-152-m01	Topology	10	NUM	20				
10-M=AVSMin-152-m01	Insurance Mathematics 1	10	NUM	21				
10-M=AZRAin-152-m01	Time Series Analysis 1	10	NUM	22				
10-M=AZTHin-152-m01	Number Theory	10	NUM	23				
10-M=AGPCin-152-m01	Giovanni Prodi Lecture (Master)	5	NUM	12				
10-M=VANAin-152-m01	Selected Topics in Analysis	10	NUM	57				
10-M=VATPin-152-m01	Algebraic Topology	10	NUM	58				
10-M=VFNMin-152-m01	Selected Topics in Financial Mathematics	10	NUM	61				
10-M=VGDSin-152-m01	Groups and their Representations	10	NUM	62				
	Geometrical Mechanics	10	NUM	63				
10-M=VISTin-152-m01	Industrial Statistics 2	10	NUM	69				
10-M=VKARin-152-m01	Field Arithmetics	10	NUM	70				
10-M=VNPEin-152-m01	Numeric of Partial Differential Equations	10	NUM	77				
10-M=VOPTin-152-m01	Selected Topics in Optimization	10	NUM	78				
10-M=VSTAin-152-m01	Statistical Analysis	10	NUM	82				
10-M=VVSMin-152-m01	Insurance Mathematics 2	10	NUM	84				
10-M=VZRAin-152-m01	Time Series Analysis 2	10	NUM	86				
10-M=VDIMin-152-m01	Discrete Mathematics	5	NUM	59				
10-M=VDSYin-152-mo1	Dynamical Systems	5	NUM	60				
10-M=VGEOin-152-m01	Aspects of Geometry	5	NUM	64				
10-M=VKOMin-152-mo1	Mathematical Continuum Mechanics	5	NUM	72				
10-M=VMBVin-152-m01	Mathematical Imaging	5	NUM	73				
10-M=VMPHin-152-mo1	Selected Topics in Mathematical Physics	10	NUM	74				
10-M=VTRTin-152-m01	Selected Topics in Control Theory	10	NUM	83				
10-M=VIPRin-152-mo1	Inverse Problems	5	NUM	68				
10-M=VMTHin-152-m01	Module Theory	5	NUM	75				
	Non-linear Analysis	5	NUM	76				
10-M=VOSTin-152-m01	Optimal Control	5	NUM	79				



10-M=VVSYin-152-m01	Networked Systems	5	NUM	85			
10-M=VKGEin-152-m01	Complex Geometry	10	NUM	71			
10-M=VPDPin-152-m01	Partial Differential Equations of Mathematical Physics	10	NUM	80			
10-M=VPRGin-152-m01	Pseudo Riemannian and Riemannian Geometry	10	NUM	81			
10-M=AFANin-152-m01	Functional Analysis	10	NUM	9			
10-M=VADGin-152-m01	Applied Differential Geometry	10	NUM	56			
10-M=VGPSin-152-m01	Giovanni Prodi Lecture Selected Topics (Master)	10	NUM	67			
10-M=VGPAin-152-m01	Giovanni Prodi Lecture Advanced Topics (Master)	10	NUM	65			
10-M=VGPMin-152-m01	Giovanni Prodi Lecture Modern Topics (Master)	10	NUM	66			
Research in Groups and S	Seminars (20-60 ECTS credits)						
10-M=GALGin-152-m01	Research in Groups - Algebra	10	NUM	24			
10-M=GDIMin-152-m01	Research in Groups - Discrete Mathematics	10	NUM	29			
10-M=GDSCin-152-m01	Research in Groups - Dynamical Systems and Control Theory	10	NUM	30			
10-M=GCOAin-152-m01	Research in Groups - Complex Analysis	10	NUM	25			
10-M=GGMTin-152-m01	Research in Groups - Geometry and Topology	10	NUM	31			
10-M=GMCXin-152-m01	Research in Groups - Mathematics in Context	10	NUM	33			
10-M=GMSCin-152-m01	Research in Groups - Mathematics in the Sciences	10	NUM	34			
	Research in Groups - Measure and Integral	10	NUM	32			
	Research in Groups - Numerical Mathematics and Applied Ana-						
10-M=GNMAin-152-m01	lysis	10	NUM	36			
	Research in Groups - Robotics, Optimization and Control Theo-						
10-M=GROCin-152-m01	ry	10	NUM	39			
10-M=GTSAin-152-m01	Research in Groups - Time Series Analysis	10	NUM	41			
10-M=GSTAin-152-m01	Research in Groups - Statistics		NUM	40			
10-M=GNTHin-152-m01	Research in Groups - Number Theory	10	NUM	37			
	Research in Groups - Control Theory of Quantum Mechanical						
10-M=GCQSin-152-m01	Systems	10	NUM	26			
10-M=GDGEin-152-m01	Research in Groups - Differential Geometry	10	NUM	28			
10-M=GDFQin-152-m01	Research in Groups - Deformation Quantization	10	NUM	27			
10-M=GNLAin-152-m01	Research in Groups - Non-linear Analysis	10	NUM	35			
10-M=GOPAin-152-m01	Research in Groups - Operator Algebras	10	NUM	38			
10-M=SADGin-152-m01	Seminar in Applied Differential Geometry	5	NUM	43			
10-M=SALGin-152-m01	Seminar in Algebra	5	NUM	44			
10-M=SDSCin-152-m01	Seminar in Dynamical Systems and Control	5	NUM	46			
10-M=SCOAin-152-m01	Seminar in Complex Analysis	5	NUM	45			
10-M=SFIMin-152-m01	Seminar in Financial and Insurance Mathematics	5	NUM	47			
10-M=SGTOin-152-m01	Seminar in Geometry and Topology	5	NUM	49			
10-M=SGPCin-152-m01	Giovanni Prodi Seminar (Master)	5	NUM	48			
10-M=SIDCin-152-m01	Interdisciplinary Seminar		NUM	50			
		5	NUM	51			
		5	NUM	53			
10-M=SOPTin-152-m01	Seminar in Optimization	5	NUM	54			
10-M=SSTAin-152-m01	Seminar in Statistics	5	NUM	55			
10-M=SNLAin-152-m01	Seminar in Non-linear Analysis		NUM	52			
10-M=SNLAin-152-mo1   Seminar in Non-linear Analysis   5   NUM   52  Thesis (30 ECTS credits)							
10-M=MAMI-152-m01	Master Thesis Mathematics International	30	NUM	42			
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Module	e title				Abbreviation	
Applie	d Analy	/sis			10-M=AAANin-152-m01	
Module coordinator				Module offered by		
Dean o	f Studi	es Mathematik (Ma	thematics)	Institute of Mathematics		
ECTS	Meth	od of grading	Only after succ. co	mpl. of module(s)		
10	nume	rical grade				
Duratio	Duration Module level Ot		Other prerequisite	Other prerequisites		
1 seme	1 semester graduate					
Conten	Contents					

In-depth study of functional analysis and operator theory, Sobolev spaces and partial differential equations, theory of Hilbert spaces and Fourier analysis, spectral theory and quantum mechanics, numerical methods (in particular FEM methods), principles of functional analysis, function spaces, embedding theorems, compactness, theory of elliptic, parabolic and hyperbolic partial differential equations with methods from functional analysis.

#### **Intended learning outcomes**

The student is acquainted with the fundamental notions, methods and results of higher analysis. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics and other natural and engineering sciences.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

creditable for bonus

#### Allocation of places

#### **Additional information**

#### Workload

300 h

#### **Teaching cycle**

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

#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation							
Topics in Algebra					10-M=AALGin-152-m01		
Modul	e coord	inator		Module offered by	<u> </u>		
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS		od of grading	Only after succ. con	pl. of module(s)			
10		rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ester	graduate					
Conter	ıts						
Conter		topics in algebra, for ex	ample coding theory,	elliptic curves, alge	braic combinatorics or computer		
Intend	ed lear	ning outcomes					
		acquainted with fundanese skills to complex que		nethods in a conter	nporary field of algebra, and is ab-		
Course	es (type	, number of weekly conta	act hours, language –	- if other than Germa	ın)		
V (4) + Modul		t in: English					
		sessment (type, scope, la			ition offered — if not every seme-		
(appro Assess Langua	x. 20 m sment o	inutes) or c) oral examin ffered: In the semester in ssessment: English	ation in groups (group	ps of 2, 15 minutes p	amination of one candidate each per candidate) ubsequent semester		
Allocat	tion of p	olaces					
Additio	onal inf	ormation					
Workload							
300 h							
	Teaching cycle						
Doforre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
VEIGII	Aciented to in LFOT (examination regulations for teaching-degree programmes)						

Module appears in

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module title					Abbreviation	
Differe	ntial G	eometry			10-M=ADGMin-152-m01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathen	natics)	Institute of Mathematics		
ECTS	Metho	od of grading	Only after succ. con	ompl. of module(s)		
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites	Other prerequisites		
1 semester graduate						
Conten	Contents					

Central and advanced results in differential geometry, in particular about differentiable and Riemannian manifolds.

#### **Intended learning outcomes**

The student is acquainted with concepts and methods for differentiable manifolds or Riemannian manifolds, is able to apply these methods and knows about the interaction of local and global methods in differential geometry.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation
Functional Analysis					10-M=AFANin-152-mo1
Module coordinator Module offered by					
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. con	mpl. of module(s)	
10	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 semester graduate					
Contents					
Banach and Hilbert spaces, hounded operators, principles of functional analysis, further contemporary topics in					

Banach and Hilbert spaces, bounded operators, principles of functional analysis, further contemporary topics in functional analysis and applications to other fields of mathematics.

#### **Intended learning outcomes**

The student is acquainted with fundamental concepts and methods in a contemporary field of functional analysis, and is able to apply these skills to complex questions.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

creditable for bonus

#### Allocation of places

#### **Additional information**

#### Workload

300 h

#### **Teaching cycle**

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

#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation	
Complex Analysis					10-M=AFTHin-152-m01	
Module	e coord	inator		Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathematics		
ECTS	Metho	od of grading	Only after succ. con	mpl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 semester graduate						
Conten	Contents					

In-depth study of mapping properties of analytic functions and their generalisations with modern analytic and geometric methods. Structural properties of families of holomorphic and meromorphic functions. Special functions (e. g. elliptic functions).

#### **Intended learning outcomes**

The student is acquainted with the fundamental notions, methods and results of higher complex analysis, in particular the (geometric) mapping properties of holomorphic functions. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and applications in other subjects.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate)
Assessment offered: In the semester in which the course is offered and in the subsequent semester

Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation
Geometric Structures					10-M=AGMSin-152-m01
Modul	e coord	inator		Module offered by	
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. con	ıpl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 semester graduate					
Contents					
Tits buildings, generalised polygons or related geometric structures, automorphisms, BN pairs in groups, Mouf-					

### **Intended learning outcomes**

ang conditions, classification results.

The student is acquainted with the fundamental notions, methods and results concerning a type of geometric structure. He/She is able to establish a connection between these results and broader theories, and learns about the interactions of geometry and other fields of mathematics.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation
Giovanni Prodi Lecture (Master)					10-M=AGPCin-152-m01
Module coordinator				Module offered by	
Dean o	f Studi	es Mathematik (Mat	hematics)	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. co	compl. of module(s)	
5	nume	rical grade			
Duratio	Duration Module level		Other prerequisite	Other prerequisites	
1 seme	1 semester graduate				
Conten	Contents				

Introduction to a specialised topic in mathematics by an international expert.

#### **Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods of a contemporary research topic in mathematics. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and applications in other subjects.

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

 $V(3) + \ddot{U}(1)$ 

Module taught in: English

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

a) written examination (approx. 60 to 90 minutes, usually chosen) or b) oral examination of one candidate each (approx. 15 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate)
Assessment offered: In the semester in which the course is offered and in the subsequent semester
Language of assessment: English

creditable for bonus

#### 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)

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#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics (2016)

Master's degree (1 major) Mathematical Physics (2016)

Master's degree (1 major) Computational Mathematics (2016)

Master's degree (1 major) Computational Mathematics (2019)

Master's degree (1 major) Mathematics (2019)

Master's degree (1 major) Mathematical Physics (2020)

Master's degree (1 major) Mathematics International (2021)

Master's degree (1 major) Computational Mathematics (2022)

Master's degree (1 major) Mathematics (2022)

Master's degree (1 major) Mathematical Physics (2022)



Module title Abbreviation					Abbreviation	
Industi	rial Sta	tistics 1			10-M=AISTin-152-m01	
Module	e coord	linator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. com	ipl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts		,			
		ameter and domain estim is, comparative analysis,			bution models, empirical distri-	
		ning outcomes	statistical product to	stills, survey sample	ing, addit sampling.	
		nasters the fundamental s	statistical mathods for	r industrial applicat	ions	
		, number of weekly conta	ct nours, language –	- ir otner than Germa	in)	
V (4) +		t in: English				
		-	navaga if ather the	on Cormon oversing	tion offered if not even come	
		ion on whether module ca			tion offered — if not every seme-	
(approx Assess	x. 20 m ment o age of a	ninutes) or c) oral examina offered: In the semester in assessment: English	ation in groups (group	os of 2, 15 minutes p		
Allocat	ion of	places				
Additio	nal inf	ormation				
Worklo	ad					
300 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in						
Master	Master's degree (1 major) Mathematics International (2015)					

Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Modul	e title		Abbreviation		
Lie The	Lie Theory				10-M=ALTHin-152-m01
Module coordinator				Module offered by	
Dean o	Dean of Studies Mathematik (Mathematics)			Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. co	npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisite	S	
1 seme	1 semester graduate				
Conter	Contents				

Linear Lie groups and their Lie algebras, exponential function, structure and classification of Lie algebras, classic examples, applications, e.g. in physics and control theory.

#### **Intended learning outcomes**

The student is acquainted with the fundamental results, theorems and methods in Lie theory. He/She is able to apply these to common problems, and knows about the interactions of group theory, analysis, topology and linear algebra.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

creditable for bonus

#### Allocation of places

#### **Additional information**

#### Workload

300 h

#### Teaching cycle

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

#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation							
Numer	Numeric of Large Systems of Equations 10-M=ANGGin-152-mo1						
Module coordinator Module offered by				Module offered by			
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics		
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)			
10	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ester	graduate					
Conter	ıts						
Discret	tisation	of elliptic differential eq	uations, classical iter	ation methods, pred	conditioners, multigrid methods.		
Intend	ed lear	ning outcomes					
					stems of equations, and knows		
		ient way to solve a given					
		, number of weekly conta	ect hours, language –	- if other than Germa	an)		
V (4) +		tin. Facilish					
		t in: English					
		<b>sessment</b> (type, scope, la ion on whether module c			ation offered — if not every seme-		
(appro Assess Langua	x. 20 m sment o	inutes) or c) oral examin iffered: In the semester in issessment: English	ation in groups (grou	ps of 2, 15 minutes p			
Allocat	tion of	places					
Additio	onal inf	ormation					
	1						
Worklo	oad						
300 h							
Teaching cycle							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appears in							
Master's degree (1 major) Mathematics International (2015)							
	naster 5 degree (2 major) matternation in (2013)						

Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module title Abbreviation					Abbreviation	
Basics	in Opti	imization			10-M=AOPTin-152-m01	
Module	coord	linator		Module offered by		
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	atics	
<b>ECTS</b>	Meth	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites	her prerequisites		
1 seme	ster	graduate				
Conten	ts					
Fundamental methods and techniques in continuous optimization, unrestricted optimization, conditions for optimality, restricted optimization, examples and applications in natural and engineering sciences as well as economics.						
Intended learning outcomes						

The student knows the fundamental methods of continous optimization, can judge their strengths and weaknesses and can decide which method is the most suitable in applications.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	e title	,		Abbreviation		
Contro	l Theor	у			10-M=ARTHin-152-m01	
Module	e coord	inator		Module offered by		
Dean o	Dean of Studies Mathematik (Mathematics)			Institute of Mathematics		
<b>ECTS</b>	Metho	od of grading	Only after succ. com	compl. of module(s)		
10	nume	rical grade				
Duratio	Duration Module level		Other prerequisites			
1 seme	1 semester graduate					
Conten	Contents					

Introduction to mathematical systems theory: stability, controllability and observability, state feedback and stability, basics in optimal control.

#### Intended learning outcomes

The student is acquainted with the fundamental notions and methods of control theory. He/She is able to establish a connection between these results and broader theories, and learns about the interactions of geometry and other fields of mathematics.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	Module title Abbreviation					
Stocha	stic Mo	odels of Risk Managemer	nt		10-M=ASMRin-152-m01	
Module	coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites	Other prerequisites		
1 seme	ster	graduate	<del></del>			
Conten	ts					
Measure theory, risk diagrams, failure mode and effects analysis, risk assessment in auditing, shortfall measures, value at risk, conditional value at risk, axiomatic of risk measures, modelling of interdependencies, copula, modelling of functional interrelations, regression models, basics in time series modelling, aggregated losses, estimates of shortfall measures, estimates of value at risk and conditional value at risk, basics in empirical time series analysis, methods of exponential smoothing, predictions and prediction domains, estimates of value at risk in time series, elementary empirical regression analysis, simulation methods.						
Intended learning outcomes						
The stu	dent is	acquainted with the fund	damental methods o	f stochastic risk ana	lysis.	

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

creditable for bonus

#### Allocation of places

#### **Additional information**

#### Workload

300 h

#### **Teaching cycle**

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

#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation					Abbreviation	
Stocha	stical	Processes			10-M=ASTPin-152-m01	
Module coordinator				Module offered by	ı	
Dean c	of Studi	es Mathematik (Mathen	natics)	Institute of Mathen	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duration	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	ıts					
Marko	v chain	s, queues, stochastic pr	ocesses in C[0,1], Bro	wnian motion, Dons	ker's theorem, projective limits.	
Intend	ed lear	ning outcomes				
		s acquainted with the fuical problems.	ndamental notions an	d methods of stocha	astical processes and can apply	
Course	es (type	, number of weekly cont	act hours, language –	- if other than Germa	an)	
V (4) +		•			-	
		nt in: English				
		sessment (type, scope, ion on whether module			ation offered — if not every seme-	
(appro Assess Langua	x. 20 m sment c	ninutes) or c) oral examin offered: In the semester assessment: English	nation in groups (grou	ps of 2, 15 minutes p		
Allocat	tion of	places				
Additio	onal inf	ormation				
	1					
Worklo	oad					
300 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Maste	Master's degree (1 major) Mathematics International (2015)					
	()					

Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module title					Abbreviation	
Topology					10-M=ATOPin-152-m01	
Module coordinator				Module offered by		
Dean o	Dean of Studies Mathematik (Mathematics)			Institute of Mathematics		
ECTS	Metho	od of grading	Only after succ. cor	npl. of module(s)		
10	nume	rical grade				
Duratio	Duration Module level		Other prerequisites	Other prerequisites		
1 semester graduate						
Contents						

Set-theoretic topology, topological invariants (e. g. fundamental group, connection), construction of topological spaces, covering spaces.

#### **Intended learning outcomes**

The student is acquainted with the fundamental results, theorems and methods in topology and is able to apply these to common problems.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



nsurance		Module title Abbreviation					
	Mathematics 1			10-M=AVSMin-152-mo1			
Module co	oordinator		Module offer	ed by			
Dean of S	tudies Mathematik (Mat	hematics)	Institute of M	athematics			
CTS M	ethod of grading	Only after su	cc. compl. of module	(s)			
ιο πι	umerical grade						
Duration	Module level	Other prereq	uisites				
semeste	r graduate						
Contents							
ypes of b	•	xpection principle,	premium calculation	life tables, life table approximations, , commutation functions, reserves and quation.			
ntended	learning outcomes						
	nt is acquainted with the opractical problems.	e fundamental noti	ons and methods of l	life insurance mathematics and can ap-			
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)							
V (4) + Ü (2) Module taught in: English							

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation	
Time S	Time Series Analysis 1				10-M=AZRAin-152-m01	
Module	e coord	inator		Module offered by		
	_	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com			
10	nume	rical grade		•		
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Additiv	e mode	el, linear filters, autocorre	lation, moving avera	ge, autoregressive p	rocesses, Box-Jenkins method.	
Intend	ed lear	ning outcomes				
The stu proble		acquainted with the fund	damental methods of	ftime series analysis	s and can apply them to practical	
Course	<b>s</b> (type	, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (4) + Module	` '	t in: English				
a) writt (appro Assess	en exam x. 20 m ment o age of a	inutes) or c) oral examina ffered: In the semester in ssessment: English	20 minutes, usually of ation in groups (group	chosen) or b) oral ex os of 2, 15 minutes p		
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
300 h	300 h					
Teachi	Teaching cycle					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	Module appears in					
	Master's degree (1 major) Mathematics International (2015)					
Master	Master's degree (1 major) Mathematics International (2021)					



Module	e title			Abbreviation		
Numbe	r Theo	ry			10-M=AZTHin-152-m01	
Module	Module coordinator			Module offered by		
Dean o	Dean of Studies Mathematik (Mathematics)			Institute of Mathematics		
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	Duration Module level		Other prerequisites			
1 semester graduate						
Conten	Contents					

Number-theoretic functions and their associated Dirichlet series resp. Euler products, their analytic theory with applications to prime number distribution and diophantine equations; discussion of the Riemann hypothesis, overview of the development of modern number theory.

#### **Intended learning outcomes**

The student is acquainted with the fundamental methods of analytics number theory, can deal with algebraic structures in number theory and knows methods for the solution of diophantine equations. He/She has insight into modern developments in number theory.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module	e title	,	Abbreviation			
Resear	ch in G	roups - Algebra		=	10-M=GALGin-152-m01	
Module	e coord	inator		Module offered by		
Dean o	Dean of Studies Mathematik (Mathematics)			Institute of Mathematics		
ECTS	Meth	od of grading	Only after succ. co	mpl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites	Other prerequisites		
1 semester graduate						
Conten	Contents					

Selected modern topics in algebra (e. g. ring theory, commutative algebra, differential algebra, local fields, computer algebra, algebras, division rings, quadratic forms).

#### **Intended learning outcomes**

The student gains insight into contemporary research problems in algebra. He/She masters advanced techniques in this field and can apply them to complex problems.

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

V(2) + S(2)

Module taught in: English

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

talk (60 to 120 minutes)

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

#### 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation					Abbreviation	
Resear	rch in G	roups - Complex Analysi	S		10-M=GCOAin-152-m01	
Module coordinator				Module offered by		
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics	
ECTS		od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conten	ıts					
		ern topics in complex an nplex analysis, value dis		imation theory, pote	ential theory, complex dynamics,	
Intend	ed lear	ning outcomes				
		ains insight into contemp this field and can apply			lysis. He/She masters advanced	
Course	es (type	, number of weekly conta	act hours, language –	- if other than Germa	an)	
V (2) + Module		t in: English				
		sessment (type, scope, la ion on whether module c			ation offered — if not every seme-	
Assess	sment o	o minutes) offered: In the semester in ossessment: English	n which the course is	offered and in the s	ubsequent semester	
Allocat	tion of	places				
Additio	onal inf	ormation	-			
Worklo	oad					
300 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Modul	Module appears in					
	Master's degree (1 major) Mathematics International (2015)					
	waster's degree (1 major) matriculates international (2013)					

Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module title					Abbreviation	
Resea	Research in Groups - Control Theory of Quantum Mechanica			al Systems	10-M=GCQSin-152-m01	
Modul	e coord	inator		Module offered by		
Dean c	of Studi	es Mathematik (Mathema		Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com	ıpl. of module(s)		
10	nume	rical grade				
Duration	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	nts					
Select	ed mod	ern topics in control theo	ry of quantum mecha	nical systems.		
Intend	ed lear	ning outcomes				
		ains insight into contemp e masters advanced tech			y of quantum mechanical sy- o complex problems.	
Course	<b>es</b> (type	, number of weekly conta	ct hours, language —	if other than Germa	ın)	
V (2) + Modul		t in: English				
		sessment (type, scope, la ion on whether module ca			ition offered — if not every seme-	
Assess	sment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester	
Alloca	tion of <sub> </sub>	olaces				
Additio	onal inf	ormation				
Worklo	oad					
300 h						
Teachi	ing cycl	e				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
<u></u>						
Modul	Module appears in					
	Master's degree (1 major) Mathematics International (2015)					
	Master's degree (1 major) Mathematics International (2021)					
Master	Master's degree (1 major) Mathematics International (2022)					



Module title Abbreviation					Abbreviation	
Resear	ch in G	roups - Deformation Qua	ntization		10-M=GDFQin-152-m01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. con	ipl. of module(s)		
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Selecte	ed mod	ern topics in deformatior	quantization.			
Intende	ed lear	ning outcomes				
		ains insight into contemp nniques in this field and			Quantization. He/She masters	
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	- if other than Germa	ın)	
V (2) + Module	` '	t in: English				
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
Assess	ment o	o minutes) ffered: In the semester ir ssessment: English	which the course is	offered and in the su	ubsequent semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
300 h						
Teachi	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	Master's degree (1 major) Mathematics International (2015)					
	Master's degree (1 major) Mathematics International (2021)					
Master	Master's degree (1 major) Mathematics International (2022)					



Module	Module title Abbreviation					
Research in Groups - Differential Geometry					10-M=GDGEin-152-m01	
Module	e coord	inator		Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathem	natics	
ECTS						
10		rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conten	ıts		,			
Selecte	ed mod	ern topics in differential g	geometry.			
Intend	ed lear	ning outcomes				
					eometry. He/She masters advan-	
		es in this field and can ap		•	`	
		, number of weekly conta	ct hours, language –	- if other than Germa	ın)	
V (2) +		t in: English				
			nguaga if other the	an Carman, avamina	tion offered — if not every seme-	
		ion on whether module ca	-		tion offered — if not every seme-	
talk (6	o to 120	o minutes)				
		ffered: In the semester in	which the course is	offered and in the su	ubsequent semester	
		ssessment: English				
Allocat	tion of <sub> </sub>	places				
Additio	nal inf	ormation				
Worklo	oad					
300 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master's degree (1 major) Mathematics International (2015)						
Master's degree (1 major) Mathematics International (2021)						



Modul	Module title Abbreviation					
Resear	Research in Groups - Discrete Mathematics 10-M=GDIMin-152-mo1					
Modul	e coord	inator		Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com	ipl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	nts					
Selecte	ed mod	ern topics in discrete ma	thematics.			
Intend	ed lear	ning outcomes				
		ains insight into contempes in this field and can ap			nematics. He/She masters advan-	
Course	<b>s</b> (type	, number of weekly conta	ict hours, language –	- if other than Germa	ın)	
V (2) +	S (2)					
Modul	e taugh	t in: English				
		<b>sessment</b> (type, scope, la ion on whether module ca			tion offered — if not every seme-	
		o minutes)				
		offered: In the semester in Issessment: English	which the course is	offered and in the su	ubsequent semester	
	tion of					
Allocal	LIOII OI	piaces				
Additio	onal inf	ormation				
		<u></u>				
Worklo	oad					
300 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master's degree (1 major) Mathematics International (2015)						
Master	Master's degree (1 major) Mathematics International (2021)					



Module title					Abbreviation	
Resear	Research in Groups - Dynamical Systems and Control Theory  10-M=GDSCin-152-m01					
Modul	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com	ıpl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	ıts					
Selecte	ed mod	ern topics in dynamical s	ystems and control th	neory.		
Intend	ed lear	ning outcomes				
		ains insight into contemp Idvanced techniques in t			stems and control theory. He/ problems.	
Course	<b>es</b> (type	, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (2) + Module		t in: English				
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester	
Allocat	tion of <sub>I</sub>	olaces				
Additio	onal inf	ormation				
Worklo	oad					
300 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	Master's degree (1 major) Mathematics International (2015)					
I	Master's degree (1 major) Mathematics International (2021)					
Master	Master's degree (1 major) Mathematics International (2022)					



Module	Module title Abbreviation					
Researc	h in Groups - (	Geometry and To		10-M=GGMTin-152-m01		
Module	coordinator			Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathem	natics	
	Method of gra	`	Only after succ. com		idites	
	numerical gra			,		
Duration	n Module	e level	Other prerequisites			
1 semes	ter graduat	te				
Content	<u> </u>					
Selected	d modern topic	cs in geometry an	d topology.			
Intende	d learning out	comes				
The stud	dent gains insi	ight into contemp	orary research proble a apply them to comp		d topology. He/She masters ad-	
Courses	(type, numbe	er of weekly conta	ct hours, language –	· if other than Germa	ın)	
V (2) + S Module	(2) taught in: Eng	glish				
			nguage — if other tha an be chosen to earn		tion offered — if not every seme-	
Assessn	to 120 minute nent offered: In ge of assessme	n the semester in	which the course is	offered and in the su	ubsequent semester	
Allocation	on of places					
	·					
Addition	nal information	n				
Workloa	Workload					
300 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module	Module title Abbreviation							
Research in Groups - Measure and Integral  10-M=GMAlin-152-r								
Module				Module offered by				
		es Mathematik (Mathema		Institute of Mathem	natics			
ECTS		od of grading	Only after succ. con	ıpl. of module(s)				
10		rical grade						
Duratio		Module level	Other prerequisites					
1 seme		graduate	<u></u>					
Conten								
functio	ns and		cted applications, e.	g. product measures	me and measure, measurable s (with Fubini's theorem and the ral spaces.			
		ning outcomes						
		<del>_</del>	orary research proble	ems in measure and	integration theory. He/She ma-			
		d techniques in this field						
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	· if other than Germa	an)			
V (2) + : Module		t in: English						
		sessment (type, scope, la ion on whether module ca			ntion offered — if not every seme-			
Assess	ment o	o minutes) iffered: In the semester in issessment: English	which the course is	offered and in the su	ubsequent semester			
Allocat	ion of <sub>l</sub>	olaces						
Additio	Additional information							
Workload								
300 h								
Teaching cycle								
Referre	d to in	LPO I (examination regu	lations for teaching-o	legree programmes)				

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	Module title Abbreviation					
Resear	ch in G	roups - Mathematics in (	Context		10-M=GMCXin-152-m01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. con	pl. of module(s)		
10		rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	its					
ven by	a histo		c region or a particula	ar field of mathemat	of the history of mathematics, gi- ics. Other possibilities arise from a.	
Intend	ed learı	ning outcomes				
The stu	ıdent re	ealises the cultural dime	nsion of mathematics	and its relation to o	ther cultural fields.	
Course	<b>s</b> (type	, number of weekly conta	act hours, language –	- if other than Germa	an)	
V (2) + Module		t in: English	-			
		sessment (type, scope, la on on whether module c			ntion offered — if not every seme-	
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	n which the course is	offered and in the s	ubsequent semester	
Allocat						
Additio	nal inf	ormation				
Worklo	ad					
300 h	300 h					
	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module	Module title Abbreviation						
Resear	esearch in Groups - Mathematics in the Sciences						
Module	e coord	inator		Module offered by			
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)			
10	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	its						
A mode	ern top	ic in mathematics in the	sciences.				
Intend	ed lear	ning outcomes					
		ains insight into contemp hniques in this field and			in the sciences. He/She masters		
Course	s (type	, number of weekly conta	act hours, language –	- if other than Germa	an)		
V (2) + Module		t in: English					
		sessment (type, scope, la ion on whether module c			ation offered — if not every seme-		
Assess	ment o	ominutes) ffered: In the semester ir ssessment: English	n which the course is	offered and in the su	ubsequent semester		
Allocat	tion of	places					
Additio	onal inf	ormation					
Worklo	ad						
300 h							
Teaching cycle							
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in							
	Master's degree (1 major) Mathematics International (2015)						
master 5 degree (1 major) matricinates international (2015)							

Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Modul	e title	Abbreviation				
Research in Groups - Non-linear Analysis					10-M=GNLAin-152-m01	
Modul	e coord	inator		Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com			
10		rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conter	ıts					
Selecte	ed mod	ern topics in non-linear a	nalysis.			
Intend	ed lear	ning outcomes				
		ains insight into contempes in this field and can ap			nalysis. He/She masters advan-	
Course	s (type	, number of weekly conta	ct hours, language –	if other than Germa	n)	
V (2) + Modul		t in: English				
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester	
Allocat	tion of <sub> </sub>	olaces				
	_					
Additio	onal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
	Master's degree (1 major) Mathematics International (2015)					
Master	Master's degree (1 major) Mathematics International (2021)					
Master	Master's degree (1 major) Mathematics International (2022)					



Module title					Abbreviation	
Resear	ch in G	roups - Numerical Mathe	Analysis	10-M=GNMAin-152-m01		
Module	e coord	inator		Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. con	ipl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Selecte	ed topio	s in numerical mathema	tics, applied analysis	or scientific compu	ting.	
Intende	ed lear	ning outcomes				
		ains insight into a conten ers advanced techniques			nathematics or applied analysis. lex problems.	
Course	s (type	, number of weekly conta	ct hours, language –	if other than Germa	ın)	
V (2) + Module	` '	t in: English				
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
	1					
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	Module appears in					
Master Master	Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)					



Module	Module title Abbreviation						
Resear	ch in G	roups - Number Theory		10-M=GNTHin-152-m01			
Modul	e coord	inator		Module offered by			
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)			
10	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conter	its						
Selecte	ed mod	ern topics in number the	ory (e. g. algebraic nu	ımber theory, modul	ar forms, diophantine analysis).		
Intend	ed lear	ning outcomes					
	_	ains insight into contemp field and can apply them			. He/She masters advanced tech-		
Course	<b>s</b> (type	, number of weekly conta	ict hours, language –	- if other than Germa	nn)		
V (2) + Module		t in: English					
		<b>sessment</b> (type, scope, la ion on whether module c			ition offered — if not every seme-		
Assess	ment o	o minutes) ffered: In the semester ir ssessment: English	which the course is	offered and in the su	ubsequent semester		
Allocat	ion of	places					
	_						
Additio	nal inf	ormation					
Workload							
300 h							
Teachi	Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						

Module appears in

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module title Abbreviati					Abbreviation		
Research in Groups - Operator Algebras					10-M=GOPAin-152-m01		
Module coordinator				Module offered by			
		es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS		od of grading	Only after succ. com				
10	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conter	ts						
Selecte	ed mod	ern topics in operator alg	ebras.				
Intend	ed lear	ning outcomes					
		ains insight into contemp this field and can apply t			ebras. He/She masters advanced		
	<u> </u>	, number of weekly conta			ın)		
V (2) +		,					
	٠,	t in: English					
		sessment (type, scope, la ion on whether module ca	-		tion offered — if not every seme-		
talk (6	o to 120	o minutes)		·			
		ffered: In the semester in	which the course is	offered and in the su	ubsequent semester		
		ssessment: English					
Allocat	ion of	olaces					
Additio	nal inf	ormation					
Worklo	ad						
300 h							
Teachi	Teaching cycle						
<u></u>							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
<del></del>							
Module appears in							
	Master's degree (1 major) Mathematics International (2015)						
Master	Master's degree (1 major) Mathematics International (2021)						



Module title					Abbreviation		
Research in Groups - Robotics, Optimization and Control Theory					10-M=GROCin-152-m01		
Modul	e coord	inator		Module offered by			
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. com	ıpl. of module(s)			
10	nume	rical grade					
Durati	on	Module level	Other prerequisites				
1 seme	ester	graduate					
Conte	nts						
Select	ed mod	ern topics in robotics, op	timisation and contro	ol theory.			
Intend	ed lear	ning outcomes					
		ains insight into contemp advanced techniques in tl			imization and control theory. He/ problems.		
Course	es (type	, number of weekly conta	ct hours, language –	if other than Germa	ın)		
V (2) + Modul		t in: English					
		sessment (type, scope, la ion on whether module ca			ition offered — if not every seme-		
Assess	sment o	o minutes) iffered: In the semester in issessment: English	which the course is	offered and in the su	ubsequent semester		
Alloca	tion of	places					
Additio	onal inf	ormation					
Workle	oad						
300 h							
Teachi	ing cycl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
	Module appears in						
	Master's degree (1 major) Mathematics International (2015)						
	Master's degree (1 major) Mathematics International (2021)						
Maste	Master's degree (1 major) Mathematics International (2022)						



Module title				Abbreviation			
Research in Groups - Statistics				10-M=GSTAin-152-m01			
Module coordinator				Module offered by			
		es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS		od of grading	Only after succ. con		idites		
10		rical grade					
Durati	on	Module level	Other prerequisites				
1 seme	ester	graduate					
Conte	nts		,				
Select	ed mod	ern topics in statistics.					
Intend	led lear	ning outcomes					
	_		oorary research probl	ems in statistics. He	/She masters advanced techni-		
ques i	n this fi	eld and can apply them t	o complex problems.				
Course	<b>es</b> (type	, number of weekly conta	act hours, language –	- if other than Germa	ın)		
V (2) +							
		t in: English					
		<b>sessment</b> (type, scope, la ion on whether module c			tion offered — if not every seme-		
		minutes)					
		ffered: In the semester in	which the course is	offered and in the su	ubsequent semester		
		ssessment: English	-				
Alloca	tion of	places					
Additio	onal inf	ormation					
Workle	oad						
300 h							
Teachi	ing cycl	e					
	<del></del>						
Referr	Referred to in LPO I (examination regulations for teaching-degree programmes)						
<del></del>							
Modul	Module appears in						
	Master's degree (1 major) Mathematics International (2015)						
Maste	Master's degree (1 major) Mathematics International (2021)						



Module title Abbreviation						
Research in Groups - Time Series Analysis					10-M=GTSAin-152-m01	
Modul	Module coordinator			Module offered by		
		es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. con			
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	nts					
Selecte	ed mod	ern topics in time series a	analysis.			
Intend	ed lear	ning outcomes				
		ains insight into contempes in this field and can ap			nalysis. He/She masters advan-	
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	- if other than Germa	ın)	
V (2) +	S (2)					
Modul	e taugh	t in: English				
		<b>sessment</b> (type, scope, la ion on whether module ca			tion offered — if not every seme-	
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester	
Allocat	tion of <sub>I</sub>	olaces				
Additio	onal inf	ormation				
Worklo	oad					
300 h						
Teachi	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	Master's degree (1 major) Mathematics International (2015)					
Master	Master's degree (1 major) Mathematics International (2021)					



Modul	e title		Abbreviation			
Master Thesis Mathematics International					10-M=MAMI-152-m01	
Module coordinator				Module offered by		
Dean	Dean of Studies Mathematik (Mathematics)			Institute of Mathematics		
ECTS	Meth	od of grading	Only after succ. cor	mpl. of module(s)		
30	nume	rical grade				
Durati	on	Module level	Other prerequisites	;		
1 semester graduate						
Contents						

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

# **Intended learning outcomes**

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

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

No courses assigned to module

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

Master's thesis (750 to 900 hours total)

Registration and assignment of topic in consultation with supervisor.

Language of assessment: English

#### Allocation of places

--

#### **Additional information**

Time to complete: 6 months.

# Workload

900 h

# **Teaching cycle**

--

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

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# Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation					Abbreviation		
Seminar in Applied Differential Geometry					10-M=SADGin-152-m01		
Modul	e coord	inator		Module offered by			
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. com	ıpl. of module(s)			
5	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ester	graduate					
Conter	ıts						
A mod	ern top	ic in applied differential g	geometry.				
Intend	ed lear	ning outcomes					
					omprehending and structuring of ate in a scientific discussion.		
Course	es (type	, number of weekly conta	ct hours, language —	if other than Germa	nn)		
S (2) Modul	e taugh	t in: English					
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-		
Assess	sment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester		
Alloca	tion of <sub> </sub>	places					
	,						
Additio	onal inf	ormation					
Worklo	oad						
150 h							
Teachi	ng cycl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Modul	Module appears in						
	Master's degree (1 major) Mathematics International (2015)						
	Master's degree (1 major) Mathematics International (2021)						
Maste	Master's degree (1 major) Mathematics International (2022)						



Module title Abbreviation					Abbreviation		
Seminar in Algebra 10-M=SALGin-152-mo					10-M=SALGin-152-m01		
Module	e coord	inator		Module offered by			
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. com	ıpl. of module(s)			
5	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conter	ıts						
A mod	ern top	ic in algebra.					
Intend	ed lear	ning outcomes					
					omprehending and structuring of ate in a scientific discussion.		
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
S (2) Module	e taugh	t in: English					
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-		
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester		
Allocat	tion of <sub>I</sub>	places					
Additio	onal inf	ormation					
Worklo	oad						
150 h							
_	ng cycl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in						
Master Master	Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021)						
Master	Master's degree (1 major) Mathematics International (2022)						



Module title Abbreviation							
Seminar in Complex Analysis					10-M=SCOAin-152-m01		
Module	coord	inator		Module offered by			
		es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS		od of grading	Only after succ. com				
5	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
A mode	ern topi	c in complex analysis.					
Intende	ed lear	ning outcomes					
			. ,	•	omprehending and structuring of ate in a scientific discussion.		
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	if other than Germa	n)		
S (2) Module	e taugh	t in: English					
		sessment (type, scope, la			tion offered — if not every seme-		
Assess	ment o	ominutes) ffered: In the semester ir ssessment: English	which the course is	offered and in the su	ubsequent semester		
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teachi	ng cycl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in						
Master Master	Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)						



Module title Abbrevi					Abbreviation		
Seminar in Dynamical Systems and Control					10-M=SDSCin-152-m01		
Module coordinator				Module offered by			
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Metho	od of grading	Only after succ. com	ıpl. of module(s)			
5	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
A mode	ern topi	c in dynamical systems a	and control.				
Intende	ed lear	ning outcomes					
			. ,	•	omprehending and structuring of ate in a scientific discussion.		
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	if other than Germa	n)		
S (2)							
		t in: English					
		sessment (type, scope, la on on whether module ca			tion offered — if not every seme-		
		minutes)					
		ffered: In the semester in ssessment: English	which the course is	offered and in the su	ıbsequent semester		
Allocat							
	1011 01 1	, accs					
Additio	nal inf	ormation					
Auditio	ilat IIII	oi iliativii					
Worklo	ad						
150 h							
Teachir	ng cvcl	 e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in						
	Master's degree (1 major) Mathematics International (2015)						
		ee (1 major) Mathematics					
Master'	Master's degree (1 major) Mathematics International (2022)						



Module title Abbreviation					Abbreviation		
Seminar in Financial and Insurance Mathematics  10-M=SFIMin-152-1					10-M=SFIMin-152-m01		
Module	e coord	inator		Module offered by			
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS		od of grading	Only after succ. com	ıpl. of module(s)			
5	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
A mode	ern topi	ic in financial and insurar	nce mathematics.				
Intende	ed lear	ning outcomes					
					omprehending and structuring of ate in a scientific discussion.		
Course	<b>s</b> (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
S (2) Module	e taugh	t in: English					
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-		
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester		
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teachi	ng cvcl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in						
	Master's degree (1 major) Mathematics International (2015)						
	Master's degree (1 major) Mathematics International (2021)						
Master	Master's degree (1 major) Mathematics International (2022)						



Module title					Abbreviation	
Giovanni Prodi Seminar (Master)					10-M=SGPCin-152-mo1	
Module coordinator				Module offered by		
Dean c	f Studi	es Mathematik (Mat	hematics)	Institute of Mathen	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. o	compl. of module(s)		
5	nume	rical grade				
Duratio	Duration Module level		Other prerequisi	Other prerequisites		
1 semester graduate						
Contents						

A modern topic in the research expertise of the current holder of the Giovanni Prodi Chair.

#### **Intended learning outcomes**

The student is able to elaborate a contemporary research topic. This includes comprehending and structuring of the topic and the available literature, preparing a talk and the ability to participate in a scientific discussion.

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

Module taught in: English

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

talk (60 to 120 minutes)

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

#### Allocation of places

#### **Additional information**

# Workload

150 h

#### Teaching cycle

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

#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics (2016)

Master's degree (1 major) Economathematics (2016)

Master's degree (1 major) Mathematical Physics (2016)

Master's degree (1 major) Computational Mathematics (2016)

Master's degree (1 major) Computational Mathematics (2019)

Master's degree (1 major) Mathematics (2019)

Master's degree (1 major) Mathematical Physics (2020)

Master's degree (1 major) Mathematics International (2021)

Master's degree (1 major) Economathematics (2021)

Master's degree (1 major) Computational Mathematics (2022)

Master's degree (1 major) Mathematics (2022)

Master's degree (1 major) Mathematical Physics (2022)

Master's degree (1 major) Mathematics International (2022)

Master's degree (1 major) Economathematics (2022)



Module t	itle	Abbreviation				
Seminar	in Geometry and Topology		10-M=SGT0in-152-m01			
Module c	oordinator		Module offered by			
	Studies Mathematik (Mathema	atics)	Institute of Mathem	natics		
	Method of grading	Only after succ. com				
5 n	umerical grade					
Duration	Module level	Other prerequisites				
1 semest	er graduate					
Contents						
A moderr	topic in geometry and topolo	ogy.				
Intended	learning outcomes					
	ent is able to elaborate a cont and the available literature, p			omprehending and structuring of ate in a scientific discussion.		
Courses	(type, number of weekly conta	act hours, language –	if other than Germa	ın)		
S (2) Module t	aught in: English					
	of assessment (type, scope, larmation on whether module co			tion offered — if not every seme-		
Assessm	o 120 minutes) ent offered: In the semester ir e of assessment: English	n which the course is	offered and in the su	ubsequent semester		
Allocatio	n of places					
Additiona	al information					
Workload	l					
150 h						
Teaching	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master's Master's	Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)					



Module title					Abbreviation	
Interdisciplinary Seminar				•	10-M=SIDCin-152-m01	
Module	e coord	inator		Module offered by		
		es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. con		idilCS	
5		rical grade		ipt. or modute(5)		
Duratio		Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	its					
A mode	ern top	ic in mathematics with in	terdisciplinary aspec	ts.		
		ning outcomes				
					omprehending and structuring of ate in a scientific discussion.	
		, number of weekly conta				
	<b>S</b> (type	, number of weekly conta	ict nours, tanguage –	- II Other than Germa	uij	
S (2) Module	e taugh	t in: English				
		<b>sessment</b> (type, scope, la ion on whether module c			tion offered — if not every seme-	
-		o minutes)	-	<u> </u>		
		ffered: In the semester ir	which the course is	offered and in the su	ubsequent semester	
Langua	age of a	ssessment: English	-		· 	
Allocat	ion of p	places				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachi	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	Master's degree (1 major) Mathematics International (2015)					
Master	Master's degree (1 major) Mathematics International (2021)					



Module	Module title Abbreviation					
Seminar Mathematics in the Sciences					10-M=SMSCin-152-m01	
Module	e coord	inator		Module offered by		
		es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. con		idites	
5		rical grade		.p.u or modulo(o)		
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ıts					
A mode	ern top	ic in mathematics in the s	sciences.			
Intende	ed lear	ning outcomes				
					omprehending and structuring of ate in a scientific discussion.	
Course	<b>s</b> (type	, number of weekly conta	ict hours, language –	- if other than Germa	ın)	
S (2)						
Module	e taugh	t in: English				
		<b>sessment</b> (type, scope, la ion on whether module ca			ation offered — if not every seme-	
Assess	ment o	o minutes) ffered: In the semester ir ssessment: English	n which the course is	offered and in the su	ubsequent semester	
Allocat	ion of p	places				
Additio	nal inf	ormation				
	1					
Worklo	ad					
150 h						
Teachi	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					
Master	Master's degree (1 major) Mathematics International (2015)					
	Master's degree (1 major) Mathematics International (2021)					
Master	Master's degree (1 major) Mathematics International (2022)					



Module title					Abbreviation		
Seminar in Non-linear Analysis					10-M=SNLAin-152-m01		
Module	Module coordinator						
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. com	ıpl. of module(s)			
5	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
A mode	ern top	ic in non-linear analysis.					
Intende	ed lear	ning outcomes					
					omprehending and structuring of ate in a scientific discussion.		
Course	<b>s</b> (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
S (2) Module	e taugh	t in: English					
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-		
Assess	ment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester		
Allocat	ion of p	places					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teachi	Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in						
Master Master	Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)						



Module title					Abbreviation	
Seminar in Numerical Mathematics and Applied Analysis					10-M=SNMAin-152-m01	
Modul	e coord	inator		Module offered by		
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com	ıpl. of module(s)		
5	nume	rical grade	<u></u>			
Durati	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conte	nts					
A mod	ern top	ic in numerical mathemat	ics or applied analys	is.		
Intend	ed lear	ning outcomes				
					omprehending and structuring of ate in a scientific discussion.	
Course	<b>es</b> (type	, number of weekly conta	ct hours, language —	if other than Germa	n)	
S (2) Modul	e taugh	t in: English				
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
Assess	sment o	o minutes) ffered: In the semester in ssessment: English	which the course is	offered and in the su	ubsequent semester	
Alloca	tion of	places				
Additio	onal inf	ormation				
Worklo	oad					
150 h						
Teachi	ing cycl	e				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Modul	Module appears in					
	Master's degree (1 major) Mathematics International (2015)					
	Master's degree (1 major) Mathematics International (2021)					
Maste	Master's degree (1 major) Mathematics International (2022)					



Module title Abbrev					Abbreviation	
Seminar in Optimization					10-M=SOPTin-152-m01	
Module	coord	inator		Module offered by		
		es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com			
5	nume	rical grade		-		
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
A mode	ern topi	c in optimisation.				
Intende	ed lear	ning outcomes				
			. ,	•	omprehending and structuring of ate in a scientific discussion.	
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	if other than Germa	n)	
S (2) Module	e taugh	t in: English				
		sessment (type, scope, la on on whether module ca			tion offered — if not every seme-	
Assess	ment o	ominutes) ffered: In the semester ir ssessment: English	which the course is	offered and in the su	ubsequent semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachi	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master Master	Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)					



Module title					Abbreviation		
Seminar in Statistics 10-M=SSTA					10-M=SSTAin-152-m01		
Modul	e coord	inator		Module offered by			
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. com	ıpl. of module(s)			
5	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ester	graduate					
Conter	nts						
A mod	ern top	ic in statistics.					
Intend	ed lear	ning outcomes					
					omprehending and structuring of ate in a scientific discussion.		
Course	<b>es</b> (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
S (2) Modul	e taugh	t in: English					
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-		
Assess	sment o	o minutes) iffered: In the semester in issessment: English	which the course is	offered and in the su	ubsequent semester		
Allocat	tion of	places					
Additio	onal inf	ormation					
Worklo	oad						
150 h							
_	Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Modul	Module appears in						
Mastei	Master's degree (1 major) Mathematics International (2015)						
	Master's degree (1 major) Mathematics International (2021)						
Mastei	Master's degree (1 major) Mathematics International (2022)						



Module title					Abbreviation		
Applie	d Differ	ential Geometry			10-M=VADGin-152-m01		
Module	e coord	inator		Module offered by			
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. compl. of module(s)				
10	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	Contents						
The module builds on the topics covered in module 10-M=ADGM and discusses selected applications of differential geometry, e. g. at the interface of control theory and mechanics (subriemannian geometry), in the smooth optimisation on manifolds or applications in physics.							

# **Intended learning outcomes**

The student is acquainted with selected advanced applications of differential geometry. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	Module title Abbreviation					
Selected Topics in Analysis 10-M=VANAin-152-m01					10-M=VANAin-152-m01	
Module coordinator Module				Module offered by		
		es Mathematik (Mathema	atics)	Institute of Mathem	 natics	
ECTS	1	od of grading	Only after succ. com			
10	1	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
		ussion of a specialised to thematical concepts.	pic in analysis taking	ginto account recent	t developments and interrelations	
Intend	ed lear	ning outcomes				
The stu			ed results in a select	ed topic in analysis,	and is able to apply these to	
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)	
V (4) +	Ü (2)					
Module	e taugh	t in: English				
		<b>sessment</b> (type, scope, la ion on whether module ca			ation offered — if not every seme-	
(approx Assess	x. 20 m ment o age of a	inutes) or c) oral examina iffered: In the semester in issessment: English	ation in groups (grou	ps of 2, 15 minutes p		
Allocat	ion of <sub> </sub>	places				
Additio	nal inf	ormation				
	-		•			
Worklo	ad					
300 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master's degree (1 major) Mathematics International (2015)						
Master	Master's degree (1 major) Mathematics International (2021)					



Module title					Abbreviation	
Algebra	aic Top	ology			10-M=VATPin-152-m01	
Module	coord	linator		Module offered by		
Dean o	f Studi	es Mathematik (Mat	hematics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. cor	npl. of module(s)		
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites	1		
1 seme	ster	graduate				
Conten	ts					
Homolo spaces	•,	omotopy invariance,	exact sequences, cohomo	ology, application to	the topology of Euclidean	
Intende	ed lear	ning outcomes				
The stu	dent is	s acquainted with ac	lvanced results in algebra	ic topology.		
Course	<b>s</b> (type	, number of weekly	contact hours, language –	- if other than Germa	an)	
V (4) + Module		nt in: English				
			pe, language — if other th ule can be chosen to earn		ation offered — if not every seme-	
a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate)  Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus						
Allocation of places						
Additional information						

300 h

Workload

# **Teaching cycle**

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

#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)

Master's degree (1 major) Mathematics International (2022)

exchange program Mathematics (2023)



Module title					Abbreviation	
Discret	e Math	ematics			10-M=VDIMin-152-m01	
Module	coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. con	npl. of module(s)		
5	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
		thods and results in a se or combinatorics)	lected field of discret	e mathematics (e. g.	coding theory, cryptography,	
Intende	ed lear	ning outcomes				
The stu	dent is	acquainted with advance	ed results in a select	ed topic in discrete i	mathematics.	
Course	<b>s</b> (type	, number of weekly conta	act hours, language –	if other than Germa	ın)	
V (3) + Module		t in: English				
		sessment (type, scope, land) on on whether module o			tion offered — if not every seme-	
a) written examination (approx. 60 to 90 minutes, usually chosen) or b) oral examination of one candidate each (approx. 15 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate) Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus						
Allocation of places						
Additio	Additional information					

# Workload

150 h

# **Teaching cycle**

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

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#### Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Quantum Engineering (2020)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation					Abbreviation	
Dynamical Systems					10-M=VDSYin-152-m01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics	
ECTS		od of grading	Only after succ. com	npl. of module(s)		
5	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	its					
Fundar	nentals	s of dynamical systems, e	e.g. stability theory, e	ergodic theory, Hami	iltonian systems.	
Intend	ed lear	ning outcomes				
The stu		nasters the mathematical	methods in the theo	ry of dynamic syster	ms, and is able to analyse their	
Course	<b>s</b> (type	, number of weekly conta	ict hours, language –	- if other than Germa	an)	
V (3) + Module		t in: English				
		sessment (type, scope, la ion on whether module c			ation offered — if not every seme-	
(approx	x. 15 mi ment o age of a	inutes) or c) oral examina ffered: In the semester in ssessment: English	ntion in groups (group	os of 2, approx. 10 m		
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Workload Workload						
150 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
	terented to in El O I (examination regulations for teaching degree programmes)					

Master's degree (1 major) Mathematics International (2021)



Modul	e title				Abbreviation	
Select	Selected Topics in Financial Mathematics				10-M=VFNMin-152-m01	
Module coordinator			Module offered by			
Dean	of Stud	ies Mathematik (Mathem	atics)	Institute of Mathem	natics	
ECTS	<del></del>	od of grading	Only after succ. con	npl. of module(s)		
10	nume	erical grade				
Durati	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conte	nts					
of asso	Selected topics in financial mathematics, e. g. conditional expectation and martingales, fundamental theorem of asset pricing in discrete time for finite spaces, American put, Snell envelope, stopping time, optimal stopping, stochastic integration, stochastic differential equations and Ito calculus, Black-Merton-Scholes model.					
Intend	ed lear	ning outcomes				
					She gains the ability to work on er skills to complex problems.	
Course	es (type	e, number of weekly cont	act hours, language –	- if other than Germa	ın)	
V (4) + Modul		nt in: English				
		sessment (type, scope, l			ation offered — if not every seme-	
(appro Assess Langua	ox. 20 n sment o age of a	mination (approx. 90 to ninutes) or c) oral examir offered: In the semester i assessment: English bonus	ation in groups (grou	ps of 2, 15 minutes p		
Alloca	tion of	places				
Additi	onal in	formation				
Workle	oad					
300 h						
	ing cyc	le				
	3 - 7 -		_			

Module appears in

Master's degree (1 major) Mathematics International (2015)

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

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation	
Groups and their Representations					10-M=VGDSin-152-m01	
Modul	e coord	linator		Module offered by		
Dean c	of Studi	es Mathematik (Math	ematics)	Institute of Mathem	natics	
ECTS	Meth	ethod of grading Only after succ.		mpl. of module(s)		
10	nume	rical grade				
Durati	on	Module level	Other prerequisites			
1 semester graduate						
Conte	nts					
Finite	nermut:	ation groups and char	acter theory of finite gro	une interrelations a	nd special techniques such as	

Finite permutation groups and character theory of finite groups, interrelations and special techniques such as the S-rings of Schur.

#### **Intended learning outcomes**

The student masters advanced algebraic concepts and methods. He/She gains the ability to work on contemporary research questions in group theory and representation theory and can apply his/her skills to complex problems.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module	Module title Abbreviation						
Geome	etrical M	Mechanics			10-M=VGEMin-152-m01		
Module coordinator				Module offered by			
Dean of Studies Mathematik (Mathematics)			hematics)	Institute of Mathematics			
ECTS	Meth	od of grading	Only after succ. cor	npl. of module(s)			
10	nume	rical grade					
Duratio	Duration Module level Other			Other prerequisites			
1 seme	1 semester graduate						
Conten	Contents						

The module builds on the topics covered in module 10-M=ADGM and discusses these in more detail: symplectic geometry, cotangent bundles and other examples of symplectic manifolds, symmetries and Noether theorem, phase space reduction, normal forms, introduction to Poisson geometry.

#### **Intended learning outcomes**

The student is acquainted with selected advanced applications of differential geometry to geometric mechanics. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Modul	e title				Abbreviation	
Aspects of Geometry 10-M=VGEOin-152-n			10-M=VGEOin-152-m01			
Modul	e coord	inator		Module offered by		
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. con			
5		rical grade		•		
Durati	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conte	nts					
		ussion of a special type o thematical structures, e.			velopments and interrelations etries.	
Intend	ed lear	ning outcomes				
	udent is ex prob	•	ed results in a select	ed field of geometry	and can apply his/her skills to	
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)						
V (3) + Modul		t in: English				
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
(appro Assess Langua	ox. 15 m sment c	inutes) or c) oral examina offered: In the semester in ossessment: English	ition in groups (group	s of 2, approx. 10 m		
Alloca	tion of	places				
Additio	onal inf	ormation				
Workle	oad					
150 h						
	ing cycl	e				
	<u> </u>					
Referr	ed to in	LPO I (examination regu	lations for teaching-o	degree programmes)		
		(		<u> </u>		
Modul	e appe	ars in				
	Module appears in					

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Modul	e title		Abbreviation		
Giovan	ıni Proc	li Lecture Advanced	Topics (Master)		10-M=VGPAin-152-m01
Modul	e coord	inator		Module offered by	
Dean of Studies Mathematik (Mathematics)			hematics)	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. co	mpl. of module(s)	
10	nume	rical grade			
Duratio	Duration Module level Other		Other prerequisite	Other prerequisites	
1 seme	1 semester graduate				
Conter	Contents				

Introduction to a specialised topic in mathematics by an international expert.

#### **Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods of a contemporary research topic in mathematics. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and applications in other subjects.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics (2016)

Master's degree (1 major) Mathematical Physics (2016)

Master's degree (1 major) Computational Mathematics (2016)

Master's degree (1 major) Computational Mathematics (2019)

Master's degree (1 major) Mathematics (2019)

Master's degree (1 major) Mathematical Physics (2020)

Master's degree (1 major) Mathematics International (2021)

Master's degree (1 major) Computational Mathematics (2022)

Master's degree (1 major) Mathematics (2022)

Master's degree (1 major) Mathematical Physics (2022)



Modul	e title			Abbreviation	
Giovan	ıni Proc	li Lecture Modern To	opics (Master)		10-M=VGPMin-152-m01
Modul	e coord	inator		Module offered by	
Dean of Studies Mathematik (Mathematics)			thematics)	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. co	mpl. of module(s)	
10	nume	rical grade			
Duration Module level Other pre		Other prerequisite	S		
1 semester graduate					
Conter	Contents				

Introduction to a specialised topic in mathematics by an international expert.

#### **Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods of a contemporary research topic in mathematics. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and applications in other subjects.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics (2016)

Master's degree (1 major) Mathematical Physics (2016)

Master's degree (1 major) Computational Mathematics (2016)

Master's degree (1 major) Computational Mathematics (2019)

Master's degree (1 major) Mathematics (2019)

Master's degree (1 major) Mathematical Physics (2020)

Master's degree (1 major) Mathematics International (2021)

Master's degree (1 major) Computational Mathematics (2022)

Master's degree (1 major) Mathematics (2022)

Master's degree (1 major) Mathematical Physics (2022)



Module	e title		Abbreviation		
Giovanni Prodi Lecture Selected Topics (Master)					10-M=VGPSin-152-m01
Module coordinator				Module offered by	
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathematics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	Duration Module level		Other prerequisites		
1 seme	1 semester graduate				
Conten	Contents				

Introduction to a specialised topic in mathematics by an international expert.

#### **Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods of a contemporary research topic in mathematics. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and applications in other subjects.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics (2016)

Master's degree (1 major) Mathematical Physics (2016)

Master's degree (1 major) Computational Mathematics (2016)

Master's degree (1 major) Computational Mathematics (2019)

Master's degree (1 major) Mathematics (2019)

Master's degree (1 major) Mathematical Physics (2020)

Master's degree (1 major) Mathematics International (2021)

Master's degree (1 major) Computational Mathematics (2022)

Master's degree (1 major) Mathematics (2022)

Master's degree (1 major) Mathematical Physics (2022)



Module	Module title Abbreviation					
Inverse	Proble	ems			10-M=VIPRin-152-m01	
Module coordinator Module offered by						
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathen	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
5	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
		or equations, ill-posed pr ds, examples of ill-posed		on theory, Tikhonov	regularisation, iterative regulari-	
Intend	ed lear	ning outcomes				
					he can apply regularisation me- ith selected inverse problems.	
Course	<b>s</b> (type	, number of weekly conta	act hours, language –	- if other than Germa	an)	
V (3) +		t in: English				
		sessment (type, scope, la ion on whether module c			ation offered — if not every seme-	
(appro	x. 15 m ment o ige of a	inutes) or c) oral examina offered: In the semester in assessment: English	ation in groups (group	os of 2, approx. 10 m		
Allocat	ion of	places				
Additio	Additional information					
			•			
Worklo	ad					
150 h						
Teachi	ng cvcl	e				
	-3 -, -(	-				
	·					

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

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021)

Module appears in



Module title Abbreviation					Abbreviation	
Industi	rial Sta	tistics 2			10-M=VISTin-152-m01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Linear models, regression analysis, nonlinear regression, experimental design, basics in time series modelling, basics in empirical time series analysis, methods of exponential smoothing, predictions and prediction domains, statistical process monitoring.						
Intend	ed lear	ning outcomes				
The stu	ıdent m	nasters advanced statistic	cal methods for indus	strial applications.		
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)	
	V (4) + Ü (2)					
Module	Module taught in: English					
		<b>sessment</b> (type, scope, la ion on whether module ca			ation offered — if not every seme-	
(approx Assess	x. 20 m ment o age of a	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (grou	ps of 2, 15 minutes p		
Allocat	ion of <sub> </sub>	places				
Additio	nal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	ed to in	LPO I (examination regu	lations for teaching-o	degree programmes)		
Module	e appea	ars in				
		ee (1 major) Mathematics	International (2015)			
Master	Master's degree (1 major) Mathematics International (2021)					
nastel	aster's degree (1 major) mathematics international (2021)					



Module	Module title				Abbreviation	
Field Ar	rithme	tics			10-M=VKARin-152-m01	
Module	coord	inator		Module offered by	1	
Dean of Studies Mathematik (Mathematics)		atics)	Institute of Mathe	matics		
ECTS	Metho	od of grading	Only after succ. compl. of module(s)			
10	nume	rical grade				
Duratio	n	Module level	Other prerequisit	ites		
1 semes	ster	graduate				
Conten	ts					
ber the	ory, e.	,	s irreducibility theo	•	th the aim of application in num- ynomials (e.g. Calitz-Wan-conjec-	

### **Intended learning outcomes**

The student masters advanced algebraic concepts and methods. He/She gains the ability to work on contemporary research questions in algebra and can apply his/her skills to complex problems.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	title			Abbreviation	
Comple	ex Geoi	metry			10-M=VKGEin-152-m01
Module	coord	inator		Module offered by	
Dean of Studies Mathematik (Mathematics) Institute of M		Institute of Mathem	natics		
ECTS	Metho	od of grading	Only after succ. compl. of module(s)		
10	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
calculu	s, com	•	olex manifolds, metri	cs on complex manif	these in more detail: Wirtinger folds (e. g. conformal, hermitian, manifolds.
Intende	d loar	ning outcomes			

#### **Intended learning outcomes**

The student knows and masters advanced methods and notions in complex differential geometry. He is familiar with the central concepts in this fied and is able to apply the fundamental proof methods independently.

 $\textbf{Courses} \ (\textbf{type}, \textbf{number of weekly contact hours, language} - \textbf{if other than German})$ 

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	e title				Abbreviation
Mathe	matical	Continuum Mechanics			10-M=VKOMin-152-m01
Module	e coord	inator		Module offered by	
		es Mathematik (Mathema	ntics)	Institute of Mathem	natics
ECTS	1	od of grading	Only after succ. com		idites
5	1	rical grade		.pu or mount(o)	
Duratio		Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	its				
Partial	differe	ntial equations and/or va	riational methods in	the context of contir	nuum mechanics.
Intend	ed lear	ning outcomes			
The stu	ıdent m		methods in mathema	atical continuum me	chanics and knows about their
	-	, number of weekly conta	ct hours, language —	· if other than Germa	ın)
V (3) +	V (3) + Ü (1)				
Module	e taugh	t in: English			
		sessment (type, scope, la on on whether module ca			tion offered — if not every seme-
(approx Assess Langua	x. 15 mi ment o	nutes) or c) oral examina ffered: In the semester in ssessment: English	tion in groups (group	s of 2, approx. 10 m	
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
150 h					
Teachi	Teaching cycle				
Referred to in LPO I (examination regulations for teaching-degree programmes)					
		<b>LPOT</b> (examination regu	lations for teaching-c	legree programmes)	
	e appea		lations for teaching-c	legree programmes)	
 Module				legree programmes)	



	le title		Abbreviation				
Mathematical Imaging 10-M=VMBVin-152-mo1							
Module coordinator Module offered by							
Dean o	of Studi	es Mathematik (Mathem	natics)	Institute of Mathe	matics		
ECTS	<del></del>	od of grading	Only after succ. cor	mpl. of module(s)			
5	nume	erical grade					
Durati	on	Module level	Other prerequisites	5			
1 seme	ester	graduate					
Conte	nts						
camer ra pict	a mode ures; a	els and camera calibration Igorithms; module might	on, rigid and non-rigid	registration, recons	elementary projective geometry, struction of 3D objects from came c methods and tomography.		
Intend	led lear	ning outcomes					
	udent n of appl		al methods in the thec	ory of image process	sing and knows about their main		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)							
Course	V (3) + Ü (1)  Module taught in: English						
V (3) +	Ü (1)	•	tact nours, language -	– if other than Germ	an)		
V (3) + Modul <b>Metho</b>	Ü (1) le taugh	nt in: English	language — if other th	an German, examin	an) ation offered — if not every seme-		
V (3) + Modul Metho ster, ir a) writ (appro Assess Langua	i Ü (1) le taugh od of as nformat ten exa ox. 15 m sment o	sessment (type, scope, lion on whether module mination (approx. 60 to inutes) or c) oral examinoffered: In the semester assessment: English	language — if other th can be chosen to earn 90 minutes, usually c nation in groups (grou	an German, examin a bonus) chosen) or b) oral ex ps of 2, approx. 10 r	ation offered — if not every seme- camination of one candidate each minutes per candidate)		
V (3) + Modul Metho ster, ir a) writ (appro Assess Langua credita	Ü (1) le taugh od of as nformat ten exa ox. 15 m sment c age of a	nt in: English  sessment (type, scope, lion on whether module mination (approx. 60 to inutes) or c) oral examinoffered: In the semester assessment: English bonus	language — if other th can be chosen to earn 90 minutes, usually c nation in groups (grou	an German, examin a bonus) chosen) or b) oral ex ps of 2, approx. 10 r	ation offered — if not every seme- camination of one candidate each minutes per candidate)		
V (3) + Modul Metho ster, ir a) writ (appro Assess Langua credita	U (1) le taugh od of as informat ten exa ox. 15 m sment c age of a able for	nt in: English  sessment (type, scope, lion on whether module mination (approx. 60 to inutes) or c) oral examinoffered: In the semester assessment: English bonus	language — if other th can be chosen to earn 90 minutes, usually c nation in groups (grou	an German, examin a bonus) chosen) or b) oral ex ps of 2, approx. 10 r	ation offered — if not every seme- camination of one candidate each minutes per candidate)		
V (3) + Modul Metho ster, ir a) writ (appro Assess Langua credita Alloca	Ü (1) le taugh od of as informat ten exa ox. 15 m sment c age of a able for tion of	sessment (type, scope, lion on whether module mination (approx. 60 to inutes) or c) oral examinoffered: In the semester assessment: English bonus	language — if other th can be chosen to earn 90 minutes, usually c nation in groups (grou	an German, examin a bonus) chosen) or b) oral ex ps of 2, approx. 10 r	ation offered — if not every seme- camination of one candidate each minutes per candidate)		
V (3) + Modul Metho ster, ir a) writ (appro Assess Langua credita Alloca	Ü (1) le taugh od of as informat ten exa ox. 15 m sment c age of a able for tion of	nt in: English  sessment (type, scope, lion on whether module mination (approx. 60 to inutes) or c) oral examinoffered: In the semester assessment: English bonus	language — if other th can be chosen to earn 90 minutes, usually c nation in groups (grou	an German, examin a bonus) chosen) or b) oral ex ps of 2, approx. 10 r	ation offered — if not every seme- camination of one candidate each minutes per candidate)		
V (3) + Modul Metho ster, ir a) writ (appro Assess Langua credita Alloca Additio	Ü (1) le taugh od of as informat ten exa ox. 15 m sment c age of a able for tion of	sessment (type, scope, lion on whether module mination (approx. 60 to inutes) or c) oral examinoffered: In the semester assessment: English bonus	language — if other th can be chosen to earn 90 minutes, usually c nation in groups (grou	an German, examin a bonus) chosen) or b) oral ex ps of 2, approx. 10 r	ation offered — if not every seme- camination of one candidate each minutes per candidate)		
V (3) + Modul Metho ster, ir a) writ (appro Assess Langua credita Alloca	Ü (1) le taugh od of as informat ten exa ox. 15 m sment c age of a able for tion of	sessment (type, scope, lion on whether module mination (approx. 60 to inutes) or c) oral examinoffered: In the semester assessment: English bonus	language — if other th can be chosen to earn 90 minutes, usually c nation in groups (grou	an German, examin a bonus) chosen) or b) oral ex ps of 2, approx. 10 r	ation offered — if not every seme- camination of one candidate each minutes per candidate)		

Master's degree (1 major) Mathematics International (2015)

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

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation	
Selected Topics in Mathematical Physics					10-M=VMPHin-152-m01	
Module coordinator Module off						
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. con	ipl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conter	ıts					
	•	cs in mathematical physics, geometric field theory,	•		uid dynamics, mathematical ma-	
Intend	ed lear	ning outcomes				
					She is able to establish a and questions in physics.	
Course	s (type	, number of weekly conta	ct hours, language –	· if other than Germa	ın)	
V (4) + Module		t in: English				
		sessment (type, scope, la ion on whether module c			tion offered — if not every seme-	
(appro Assess Langua	x. 20 m sment o	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (group	os of 2, 15 minutes p		
Allocat	tion of <sub> </sub>	olaces				
	·					
Additio	Additional information					
Worklo	nad					
AAOIKIU	VUIKUdu					

300 h

**Teaching cycle** 

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

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# Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module	Module title Abbreviation					
Module	e Theor	у			10-M=VMTHin-152-m01	
Madula	Module coordinator Module offered by					
			\	Module offered by		
		es Mathematik (Mathema		Institute of Mathem	natics	
ECTS		od of grading rical grade	Only after succ. com	ipi. or module(s)		
5 <b>Duratio</b>		Module level	Other prerequisites			
1 seme		graduate				
Conten		Sidduce				
					n and representations, simple, sion theorems, reduction theo-	
Intende	ed lear	ning outcomes				
The stu	ıdent m	nasters mathematical met	thods in module theo	ory and is able to ana	alyse their quality.	
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	if other than Germa	ın)	
V (3) + Module		t in: English				
		sessment (type, scope, la ion on whether module ca			ition offered — if not every seme-	
(approx Assess	x. 15 m ment o ige of a	inutes) or c) oral examina ffered: In the semester in ssessment: English	tion in groups (group	s of 2, approx. 10 m		
Allocat	ion of <sub> </sub>	places				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in						
	Master's degree (1 major) Mathematics International (2015)					

Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Module title Abbreviation							
Non-lii	near An	alysis	10-M=VNANin-152-m01				
Modul	e coord	inator		Module offered by			
Dean c	of Studi	es Mathematik (Mathen	natics)	Institute of Mathen	natics		
ECTS		od of grading	Only after succ. con	npl. of module(s)			
5	nume	rical grade					
Duratio	on	Module level	Other prerequisites	i			
1 seme	ester	graduate					
Conter	nts						
Metho	ds in no	onlinear analysis (e. g. t	opological methods, n	nonotony and variati	ional methods) with applications.		
Intend	ed lear	ning outcomes					
		acquainted with the co	ncepts of non-linear a	nalysis, can compar	e them and assess their applica-		
Course	es (type	, number of weekly cont	act hours, language –	- if other than Germa	an)		
V (3) + Modul		t in: English					
					ation offered — if not every seme-		
(appro Assess Langua	ster, information on whether module can be chosen to earn a bonus)  a) written examination (approx. 60 to 90 minutes, usually chosen) or b) oral examination of one candidate each (approx. 15 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate)  Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus						
Alloca	Allocation of places						
Additio	Additional information						
Workle	Norkload						

Workload

150 h

**Teaching cycle** 

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

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Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	e title		Abbreviation		
Numeric of Partial Differential Equations					10-M=VNPEin-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathematics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites	i	
1 semester graduate					
Conten	Contents				

Types of partial differential equations, qualitative properties, finite differences, finite elements, error estimates (numerical methods for elliptic, parabolic and hyperbolic partial differential equations; finite elements method, discontinuous Gelerkin finite elements method, finite differences and finite volume methods).

## **Intended learning outcomes**

The student is acquainted with advanced methods for discretising partial differential equations.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation					Abbreviation	
Selecte	ed Topi	cs in Optimization			10-M=VOPTin-152-m01	
Module coordinator				Module offered by		
Dean o	of Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conten	ıts					
		cs in optimization, e. g. i timization with different		semidefinite progran	ns, non-smooth optimization, ga-	
Intend	ed lear	ning outcomes				
		s acquainted with advanger research questions in c			He gains the ability to work on	
Course	s (type	, number of weekly cont	act hours, language –	- if other than Germa	an)	
V (4) + Module		it in: English				
		sessment (type, scope, l ion on whether module o			ation offered — if not every seme-	
(appro Assess	x. 20 m sment c age of a	ninutes) or c) oral examir offered: In the semester in ssessment: English	ation in groups (grou	ps of 2, 15 minutes p		
Allocat	tion of	places				
Additio	onal inf	ormation				
Workload						
300 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
	telefication in El O 1 (examination regulations for teaching degree programmes)					

Module appears in

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Modul	e title				Abbreviation	
Optima	al Conti	ol			10-M=VOSTin-152-m01	
Modul	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. com	ipl. of module(s)		
5	nume	rical grade	-			
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conter	nts					
		mal control of ordinary ar ethods for numerical solu		equations, theory of	f optimal control, conditions for	
Intend	ed lear	ning outcomes				
		acquainted with advanc		al control. He gains	the ability to work on contempo-	
Course	s (type	, number of weekly conta	ct hours, language –	if other than Germa	n)	
V (3) +	` '	t in: English				
		sessment (type, scope, la			tion offered — if not every seme-	
(appro Assess Langua	x. 15 mi sment o	nutes) or c) oral examina ffered: In the semester in ssessment: English	ition in groups (group	s of 2, approx. 10 m		
Allocat	tion of p	olaces				
Additional information						
<del></del>						
Worklo	ad					
150 h						

**Teaching cycle** 

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

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# Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module	e title		Abbreviation		
Partial Differential Equations of Mathematical Physics					10-M=VPDPin-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 semester graduate					
Conten	Contents				
Fllintic	narah	olic and hyperbolic equa	ations. Lanlace equat	ion heat equation a	and wave equation as standard

Elliptic, parabolic, and hyperbolic equations; Laplace equation, heat equation and wave equation as standard examples; initial and boundary value problems; well-posed and ill-posed problems; solution methods; extensions and generalisations; Hilbert space methods; Sobolev spaces and Fourier transforms.

## **Intended learning outcomes**

The student is acquainted with fundamental concepts and solution methods in the theory of partial differential equations, as well as standard examples from mathematical physics. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module	e title			Abbreviation	
Pseudo Riemannian and Riemannian Geometry					10-M=VPRGin-152-m01
Modul	e coord	linator		Module offered by	
Dean o	of Studi	es Mathematik (Ma	thematics)	Institute of Mathematics	
ECTS	Meth	od of grading	Only after succ. co	mpl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisite	es	
1 seme	1 semester graduate				
Conter	Contents				

The module builds on the topics covered in module 10-M=ADGM and discusses these in more detail: Riemannian and pseudo-Riemannian manifolds, Levi-Civita connection and curvature, geodesics and the exponential map, Jacobi fields, comparison theorems in Riemannian geometry, submanifolds, integration, d'Alembert and Laplace operators, causal structure of Lorenz manifolds, Einstein equations and applications in general relativity theory.

### Intended learning outcomes

The student is acquainted with advanced topics in differential geometry on Riemannian and pseudo-Riemannian manifolds. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics.

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate) Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

creditable for bonus

## Allocation of places

#### **Additional information**

#### Workload

300 h

#### Teaching cycle

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

## Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Physics International (2020)

Master's degree (1 major) Mathematics International (2021)



Module	title				Abbreviation		
Statist		alysis			10-M=VSTAin-152-mo1		
	_			Module offered by			
		es Mathematik (Mathema		Institute of Mathen	natics		
<b>ECTS</b> 10		od of grading rical grade	Only after succ. con	ipi. or module(s)			
Duratio		Module level	Other prerequisites				
1 seme		graduate					
Conten		Sidduce					
		ables, categorical regress ction analysis, cluster an			-factorial variance analysis, dis- tor analysis.		
Intende	ed lear	ning outcomes					
The stu probler		acquainted with the fun	damental methods ir	statistical analysis	and can apply them to practical		
Course	<b>s</b> (type	, number of weekly conta	ct hours, language –	if other than Germa	an)		
V (4) + Module		t in: English					
		sessment (type, scope, la on on whether module c			ation offered — if not every seme-		
(approx Assess	x. 20 m ment o ige of a	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (grou	ps of 2, 15 minutes p			
Allocat	ion of <sub>l</sub>	olaces					
Additio	nal inf	ormation					
Worklo	Workload						
300 h	300 h						
Teachi	ng cycl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						

Module appears in

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation					Abbreviation		
Selected Topics in Control Theory					10-M=VTRTin-152-m01		
Modul	e coord	linator		Module offered by			
Dean c	of Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. con	pl. of module(s)			
10	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ester	graduate					
Conter	ıts						
	ed topi ır syste		ar control theory, e. g.	networked linear co	ntrol systems, controllability of		
Intend	ed lear	ning outcomes					
		ains insight into contem this field and can apply			y. He/She masters advanced		
Course	es (type	, number of weekly conta	act hours, language –	- if other than Germa	an)		
V (4) + Modul		nt in: English					
					ntion offered — if not every seme-		
(appro Assess Langua	ster, information on whether module can be chosen to earn a bonus)  a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate)  Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus						
Allocat	tion of	places					
Additio	Additional information						
Worklo	oad						
300 h							

**Teaching cycle** 

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

# Module appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title					Abbreviation	
Insurance Mathematics 2				10-M=VVSMin-152-m01		
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Contents						
					nodels regarding one life or two he product measure approach,	

# **Intended learning outcomes**

ons, joint life policies.

The student is acquainted with advanced methods in insurance mathematics. He gains the ability to work on contemporary research questions in insurance mathematics and can apply his/her skills to complex problems.

Markov chain models, Kolmogorov's differential equations, Thiele's differential equations, numerical applicati-

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

 $V(4) + \ddot{U}(2)$ 

Module taught in: English

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

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

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: 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 appears in

Master's degree (1 major) Mathematics International (2015)

Master's degree (1 major) Mathematics International (2021)



Module title Abbreviation												
Netwo	rked Sy	stems			10-M=VVSYin-152-m01							
Module	e coord	inator		Module offered by								
Dean of Studies Mathematik (Mathema			atics)	Institute of Mathematics								
ECTS												
5	nume	rical grade										
Duration		Module level	Other prerequisites									
1 semester		graduate										
Conten	ts											
Contemporary topics in networked linear and non-linear dynamical systems (homogenous and non-homogenous												
systems); analysis of control-theoretical aspects (controllability, accessibility, etc.).												
Intended learning outcomes												
The student is acquainted with advanced methods in the field of networked systems. He gains the ability to work on contemporary research questions in networked systems.												
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)												
$V(3) + \ddot{U}(1)$												
Module taught in: English												
<b>Method of assessment</b> (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. 60 to 90 minutes, usually chosen) or b) oral examination of one candidate each (approx. 15 minutes) or c) oral examination in groups (groups of 2, approx. 10 minutes per candidate) Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus												
Allocat	ion of p	olaces										
Additional information												
Workload												
150 h												
Teaching cycle												
Referred to in LPO I (examination regulations for teaching-degree programmes)												
Module	e appea	ars in		Module appears in								

Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022)



Modul	e title				Abbreviation				
Time S	eries A	nalysis 2			10-M=VZRAin-152-m01				
Modul	e coord	linator		Module offered by					
Dean of Studies Mathematik (Mathema			atics)	Institute of Mathematics					
ECTS	Meth	od of grading	Only after succ. con						
10	nume	rical grade							
Duration		Module level	Other prerequisites						
1 semester		graduate							
Conter	nts								
State-space models, Kalman filter, frequency spaces, Fourier analysis, periodograms, characterisation of autocovariance functions.									
Intended learning outcomes									
The student is acquainted with advanced methods in time series analysis. He gains the ability to work on contemporary research questions in this field.									
Course	es (type	, number of weekly conta	act hours, language –	- if other than Germa	an)				
V (4) + Ü (2) Module taught in: English									
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)									
a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate) Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus									
Alloca	tion of	places							
Additio	onal inf	ormation							
Worklo	oad								
300 h									
Teaching cycle									
Referred to in LPO I (examination regulations for teaching-degree programmes)									
Modul	e appe	ars in							
		ree (1 major) Mathematics	s International (2015)						
material degree (a major) material and material (2013)									