

Module Catalogue

for the Module studies (Master)

Mathematics

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

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The subject is divided into

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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:

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

15-May-2019 (2019-36)

27-Jun-2019 (2019-41)

14-Nov-2019 (2019-52)

22-Jan-2020 (2020-13)

o6-May-2020 (2020-39)

22-Jul-2020 (2020-57)

17-Dec-2020 (2020-110)

10-Mar-2021 (2021-17)



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o9-Jun-2021 (2021-58)
22-Dec-2021 (2021-85)
o5-Jul-2022 (2022-52)
31-Jan-2023 (2022-86)
15-Jun-2023 (2023-58)
13-Dec-2023 (2023-107)
o7-Aug-2024 (2024-82)
22-Jan-2025 (2025-1)
o9-Jul-2025 (2025-75)
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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.



Winter Term 2019

(o ECTS credits)



Module	Module title Abbreviation					
Resear	ch in G	roups - Deformation Qua	10-M=GDFQ-161-m01			
Module	Module coordinator			Module offered by	,	
Dean o	f Studie	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				
Conten	ts					
Selecte	d mod	ern topics in deformatior	quantization.			
		d previous knowledge: the contents of the modu	ules "Differential Geo	metry" and "Geomet	ric Mechanics" is recommended.	
Intende	Intended learning outcomes					
	The student gains insight into contemporary research problems in Deformation Quantization. He/She masters advanced techniques in this field and can apply them to complex problems.					
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	rman)		
V (2) + Module	` '	t in: German and/or Engl	ish			
		eessment (type, scope, langua le for bonus)	ge $-$ if other than German, \circ	examination offered — if no	ot every semester, information on whether	
Langua	ge of a	minutes) ssessment: German or E ffered: In the semester ir		offered and in the su	ubsequent semester	
Allocat	ion of p	olaces				
Additio	Additional information					
Workload						
300 h	300 h					
Teachi	Teaching cycle					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					



Module title					Abbreviation	
Seminar in Non-linear Analysis					10-M=SNLA-161-m01	
Modul	e coord	inator		Module offered by		
Dean c	of Studi	es Mathematik (Mathen	natics)	Institute of Mathen	natics	
ECTS	Metho	od of grading	Only after succ. co	mpl. of module(s)		
5	nume	rical grade				
Duratio	on	Module level	Other prerequisites	5		
1 seme	ester	graduate				
Conter	nts					
A mod	ern topi	ic in non-linear analysis	•			
Intend The stu the top	ed lear udent is oic and		ntemporary research to preparing a talk and t	he ability to particip	omprehending and structuring of ate in a scientific discussion.	
S (2) Modul	e taugh	t in: German and/or Eng	glish			
Metho	d of ass			examination offered — if no	ot every semester, information on whether	
Langua	age of a	o minutes) ssessment: German or ffered: In the semester	_	offered and in the s	ubsequent semester	
Alloca	tion of p	olaces				
Additio	onal inf	ormation				
Workload						
150 h	150 h					
T l- !	ing cycl					

 $\textbf{Referred to in LPO I} \ \ (\text{exa}\underline{\text{mination regulations for teaching-degree programmes}})$



Summer Term 2021

(o ECTS credits)



Module title				Abbreviation	
Algorit	Algorithmic Number Theory			10-M=VAZT-192-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	mpl. of module(s)	
10	nume	rical grade			
Duration Module level Other prere		Other prerequisites	S		
1 seme	ster	graduate			
Contents					

Binary numbers, computation of the greatest common divisor, pseudoprime tests, computation of primitive roots. Primality tests for Fermat and Mersenne numbers, factorisation methods (Pollard-Rho, (p-1)-method, elliptic curve method, quadratic sieve method), discrete logarithm.

Recommended previous knowledge:

Basic knowledge of algebra and number theory is assumed, such as can be acquired in the modules "Introduction to Algebra", "Introduction to Number Theory" and "Applied Algebra".

Intended learning outcomes

The student knows about the theoretical foundations and the possible applications of several methods in algorithmic number theory.

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

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

Module taught in: German and/or English

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

- a) written examination (approx. 90 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)

Language of assessment: German or English

Assessment offered: In the semester in which the course is offered and in the subsequent semester 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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$\textbf{Referred to in LPO I} \ \ (\text{examination regulations for teaching-degree programmes})$



Winter Term 2021

(o ECTS credits)



Module title				Abbreviation	
Algorithmic Number Theory			10-M=VAZT-192-m01		
Module coordinator Module offered			Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathematics	
ECTS	Metho	od of grading	Only after succ. compl. of m		
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate			
Contents					
Binary numbers, computation of the greatest common divisor, pseudoprime tests, computation of primitive roots. Primality tests for Fermat and Mersenne numbers, factorisation methods (Pollard-Rho, (p-1)-method, ellip-					

Recommended previous knowledge:

Basic knowledge of algebra and number theory is assumed, such as can be acquired in the modules "Introduction to Algebra", "Introduction to Number Theory" and "Applied Algebra".

Intended learning outcomes

The student knows about the theoretical foundations and the possible applications of several methods in algorithmic number theory.

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

tic curve method, quadratic sieve method), discrete logarithm.

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

Module taught in: German and/or English

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

- a) written examination (approx. 90 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)

Language of assessment: German or English

Assessment offered: In the semester in which the course is offered and in the subsequent semester 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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 $\textbf{Referred to in LPO I} \ \ (\text{examination regulations for teaching-degree programmes})$



Module title				Abbreviation	
Applied Analysis			10-M=AAAN-		10-M=AAAN-161-m01
Module coordinator				Module offered by	
Dean c	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			
Duration Module level Oth		Other prerequisite	Other prerequisites		
1 semester graduate					
Conter	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.

Recommended previous knowledge:

Familiarity with the contents of the module "Functional Analysis" is strongly recommended.

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)

Module taught in: German and/or English

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

- a) written examination (approx. 90 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)

Language of assessment: German or English

Assessment offered: In the semester in which the course is offered and in the subsequent semester 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 title					Abbreviation
Research in Groups - Algebra					10-M=GALG-161-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS	S Method of grading Only after succ. comp			npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites	sites	
1 seme	ster	graduate			
Conten	its				
Selected modern topics in algebra (e. g. ring theory, commutative algebra, differential algebra, local fields, computer algebra, algebras, division rings, quadratic forms).					
Recommended previous knowledge:					

Basic knowledge of algebra is assumed, such as can be acquired in the modules "Introduction to Algebra" and "Applied Algebra".

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: German and/or English

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

talk (60 to 120 minutes)

Language of assessment: German or English

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

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Additional information

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Workload

300 h

Teaching cycle

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 $\textbf{Referred to in LPO I} \ \ (\text{examination regulations for } \underline{\text{teaching-degree programmes}})$



Module title					Abbreviation	
Research in Groups - Deformation Quantization 10-M=GDFQ-161-mo1					10-M=GDFQ-161-m01	
Modul	e coord	inator		Module offered by		
Dean c	of Studio	es Mathematik (Mathem	atics)	Institute of Mathen	natics	
ECTS	Metho	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	nts					
Selecte	ed mod	ern topics in deformation	n quantization.			
Intend The stu	ed lear udent ga	ning outcomes	oorary research probl	ems in Deformation	tric Mechanics" is recommended. Quantization. He/She masters	
		number of weekly contact hours,		· · · · · · · · · · · · · · · · · · ·		
V (2) +	S (2)	t in: German and/or Eng		ind.i)		
		sessment (type, scope, langualle for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on whether	
Langua	talk (60 to 120 minutes) Language of assessment: German or English Assessment offered: In the semester in which the course is offered and in the subsequent semester					
Allocation of places						
Additio	onal inf	ormation	,			
Worklo	Workload					
300 h	300 h					

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Teaching cycle

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



Module title Abbreviation					Abbreviation
Research in Groups - Differential Geometry 10-M=GDGE-161-mo1					10-M=GDGE-161-m01
Module coordinator Module of			Module offered by		
Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathen	natics
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 seme	ester	graduate			
Conter	nts				
Selecte	ed mod	ern topics in differential	geometry.		
"Pseud Intend The stu	do-Riem ed lear udent g	nannian and Riemannian ning outcomes ains insight into contemp	Geometry" and "Lie I	heory" is also recon	ometry", "Geometric Mechanics", nmended. Geometry. He/She masters advan-
		es in this field and can ap			
		number of weekly contact hours,	language — if other than Ge	rman)	
V (2) + Modul	` '	t in: German and/or Engl	ish		
Metho	d of ass			examination offered — if n	ot every semester, information on whether
Langua	age of a	o minutes) ssessment: German or E ffered: In the semester in		offered and in the s	ubsequent semester
Allocation of places					
Additio	onal inf	ormation			
Worklo	oad				
300 h					

Teaching cycle

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



Module	e title		Abbreviation			
Selected Topics in Analysis				10-M=VANA-161-m01		
Module	e coord	inator		Module offered by		
Dean of Studies Mathematik (Mathematics) Institut			Institute of Mathem	natics		
ECTS	Metho	od of grading	Only after succ. con	Only after succ. compl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites	1		
1 seme	ster	graduate				
Contents						
In-depth discussion of a specialised topic in analysis taking into account recent developments and interrelations with other mathematical concepts.						

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Recommended previous knowledge:

Depending on the content, basic and advanced knowledge from different areas of analysis is required. In case of doubt, it is recommended to consult the lecturer.

Intended learning outcomes

The student is acquainted with advanced results in a selected topic in analysis, and is able to apply these to complex problems.

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

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

Module taught in: German and/or English

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

- a) written examination (approx. 90 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)

Language of assessment: German or English

Assessment offered: In the semester in which the course is offered and in the subsequent semester 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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 $\textbf{Referred to in LPO I} \ \ (\text{examination regulations for teaching-degree programmes})$



Module title				Abbreviation	
Geome	Geometric Complex Analysis			10-M=VGFT-192-m01	
Module	Module coordinator Module offered by			Module offered by	
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics			
ECTS	TS Method of grading Only after succ. com		npl. of module(s)		
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ester	graduate			_
Contents					
Advanced methods and results in geometric complex analysis (e.g. conformal maps, conformal Riemannian metrics, quasiconformal maps, harmonic functions, biholomorphic maps).					

Recommended previous knowledge:

Basic knowledge of the contents of the module "Introduction to Complex Analysis" is recommended.

Intended learning outcomes

The student is acquainted with fundamental concepts, methods and results in geometric complex analysis, is able classify these results within more general theories and knows about the connections of geometric complex analysis with other fields of mathematics.

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

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

Module taught in: German and/or English

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

- a) written examination (approx. 90 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)

Language of assessment: German or English

Assessment offered: In the semester in which the course is offered and in the subsequent semester 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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 $\textbf{Referred to in LPO I} \ \ (\text{examination regulations for teaching-degree programmes})$



Modul	e title				Abbreviation			
Partial	Differe	ntial Equations of Mathe	ematical Physics		10-M=VPDP-161-m01			
Modul	e coord	inator		Module offered by				
Dean of Studies Mathematik (Mathema			atics)	Institute of Mathematics				
ECTS	ECTS Method of grading		Only after succ. compl. of module(s)					
10	nume	rical grade						
Duration		Module level	Other prerequisites					
1 semester		graduate						
Contents								
Basic k Equation Intendent The stu	knowled ons" is ed lear udent is	recommended, as well a ning outcomes acquainted with fundan	s basic knowledge of nental concepts and s	functional analysis.	duction to Partial Differential the theory of partial differential able to establish a connection			
		ner acquired skills and ot						
Courses (type, number of weekly contact hours, language — if other than German)								
V (4) + Modul		t in: German and/or Engl	ish					
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)								
		mination (approx. 90 to 1	20 minutes usually	chosen) or				
b) oral c) oral Langua Assess	examir examin age of a	nation of one candidate e ation in groups (groups of ssessment: German or E ffered: In the semester in	each (approx. 20 minu of 2, 15 minutes per c nglish	utes) or andidate)	ubsequent semester			
b) oral c) oral Langua Assess credita	examir examin age of a sment o	nation of one candidate e ation in groups (groups of ssessment: German or E ffered: In the semester in bonus	each (approx. 20 minu of 2, 15 minutes per c nglish	utes) or andidate)	ubsequent semester			

Additional information

Workload

300 h

Teaching cycle

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



					I				
Modul			Abbreviation						
Semin	ar Math	nematics in the Sciences		10-M=SMSC-161-m01					
Modul	e coord	inator		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)					
5	nume	rical grade							
Duration		Module level	Other prerequisites						
1 semester		graduate							
Contents									
A modern topic in mathematics in the sciences.									
Recommended previous knowledge: Basic knowledge from the modules "Ordinary Differential Equations" and "Introduction to Partial Differential Equations" is recommended, as well as basic knowledge of functional analysis. 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)									
S (2) Module taught in: German and/or English									
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)									
talk (60 to 120 minutes) Language of assessment: German or English Assessment offered: In the semester in which the course is offered and in the subsequent semester									
Allocation of places									
Additional information									
Workload									
150 h									
Teachi	ng cycl	e							

 $\textbf{Referred to in LPO I} \ \ (\text{exa}\underline{\text{mination regulations for teaching-degree programmes})}$