Module handbook for the degree programmes oft the Department of Mathematics and the Department's teaching service

valid as of Winter Semester 2024/25 in accordance with the resolution of the Departmental Council, dated 25.10.2024.

This is a beta version!





10117		ysis 1 Cradit I	Dointa	Workload	Self-study	Duratio	•	From	2001		
							-	requency very 2. semeste			
				27011				· ·	2. Semester		
	guage of man	Instruct	lion		Person responsit						
1	man Prof. Dr. rer. nat. Matthias Hieber										
-	Course		Course	name	Workload (CP)			of ning	Contact Hours per Week		
	04-00-0003-tt Analysis			I	0		Convention		1		
	04-00-0	003-vu	Analysis	I	0		Lectur Exercis		6		
3	After th -analys differer	e functiontiability	letion of ons in on and Riei	this course, the stu e real variable using mann integrability	; fundamental con	·		nit, con	tinuity,		
4			for Partic	sults in this context cipation	with different me	thods of p	oroof				
	none Form of Examination Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Standard) Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral examples of the exam of the exa							andard)			
5	Usually	the exa	m is take	n in form of a writt	en test (90 min), e	xcept wh	en the	re are o	nly a smal		

	Bestehen der Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Bachelor Physics
9	Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I, II. Vieweg M. Hieber: Analysis I, Springer K. Königsberger: Analysis 1, 2, Springer Charles R. MacCluer, Honors Calculus, Princeton Univ. Press W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment

Mod	dule nam	ie											
	Analy	ysis 1 (e	nglisch										
Мос	dule no.	Credit F	Points	Workload S		Self-	study	Duration		Frequency			
04-0	04-00-0002 9 CP				270 h		165 h	1 Semester Every		Every	ery 2. semester		
Lang	Language of Instruction						Person responsible for the Module						
English						Prof.	Dr. rer. nat.	Matthias	6 Hiebe	r			
1	Courses	s of the	Module										
	Course no. Course		name			Workload (CP)		Form of Teaching		Contact Hours per Week			
	04-00-00	040-tt	Analysis	s I (english)			0		Convention		1		
	04-00-00	040-vu	Analysis	I (english)			0		Lectur Exercis		6		
2	compac Taylor's	d comple tness, e Theore	lementa	ry functions, ral calculus,	differe	ntial	ences and se calculus, Mea l Theorem of	an Value	Theore				

3	Learning Outcomes
	Nach dem Besuch des Moduls können die Studierenden
	- Funktionen einer reellen Variablen mit grundlegenden Konzepten (Grenzwert, Stetigkeit,
	Differenzierbarkeit, Vollständigkeit usw.) analysieren
	- mathematische Schlussfolgerungen mit verschiedenen Beweismethoden herleiten
4	Requirements for Participation
	keine
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	1. Jahr Bachelor
9	Literature
	H. Amman, J. Escher: Analysis II, Birkhäuser
	O. Forster: Analysis I, II. Vieweg M. Hieber: Analysis I, Springer
	K. Königsberger: Analysis 1, 2, Springer
	Charles R. MacCluer, Honors Calculus, Princeton Univ. Press
	W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment

Module nam	ne											
Analysis 2												
Module no.	Module no. Credit Points Workload Self-study Duration Frequency											
04-00-0003	9 CP		270 h		165 h	1 Semester	Every 2. semester					

	guage of Instruc	tion		Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber						
	man		Prof.	Dr. rer. nat. Matth	nias Hieber					
1	Courses of the	Module								
	Course no.	Course name		Workload (CP)	Form of Teaching	Contact Hours per Week				
	04-00-0002-tt	Analysis II		0	Convention	1				
	04-00-0002-vu Analysis II 0 Lecture and 6 Exercise 6									
2	Study Content									
	Normen, Differentialrechnung mehrerer Variablen, partielle Ableitungen, Ableitungsregeln, Gradient, Höhere Ableitungen und Satz von Taylor in mehreren Variablen Lokale Extrema Lokale Umkehrbarkeit und implizite Funktionen Kurven, Wege und Vektorfelder Konvergenz von Fourrierreihen Parsevalsche Gleichung									
	Learning OutcomesAfter the completion of this course, the students are able to-analyse functions in several real variable using fundamental concepts such as norms, continuin normed spaces, partial and total differentiability and integrability-investigate geometric properties in higher dimensional spaces using basic topological concept									
4	Requirements recommended	for Participation : Analysis 1								
5	Form of Examination									
	Final Module E									
	• Modu									
	Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam (30 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.									
6	Requirements Passing the Fac	on the Award of Credit P	Points							
7	Grading Final Module E	xamination:								

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Bachelor physics
9	Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis II, Springer K. Königsberger: Analysis 1,2, Springer W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment

	Anal	ysis 2 (e	englisch)									
Мо	dule no.	Credit I	Points	Workload	Self-stu	-study Duratio		n Frequency		ncy		
04-	00-0004		9 CP	270 h		165 h 1 Semes		ster Every 2		. semestei		
Lan	guage of	Instruct	tion		Person	responsib	le for the	Modul	е			
English						. rer. nat.	Matthias	Hieber				
1	Course	s of the	Module									
	Course no.		Course	urse name		Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-00-0011-tt Ana		Analysis	ysis II (english)		0		Convention		1		
	04-00-0	04-00-0011-vu Analysis		I (englisch)	0	0		Lecture and Exercise		6		
2	Study C	Study Content										
	Normer Gradier Höhere Lokale Lokale Kurven Konver	n, Differ nt, Ableitu Extrema Umkehr , Wege u genz vor	entialrec ngen und		mehrere	oartielle A	bleitunge		-	egeln,		

3	Learning Outcomes
	Nach dem Besuch des Moduls können die Studierenden
	Europeise and the second se
	- Funktionen, die von mehreren Variablen abhängen, mit grundlegenden Konzepten (Stetigkeit,
	totale und partielle Differenzierbarkeit, Integration) analysieren
	- geometrische Zusammenhänge in mehrdimensionalen Raeumen mit topologischen
	Grundkonzepten untersuchen
4	Requirements for Participation
	Recommended: Analysis I
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Usually the exam is taken in form of a written test (90 min), except when there are only a small
	number of potential participants. In this case, the exam can be taken in the form of an oral exam
	(30 min). The decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking
	the exam.
-	
6	Requirements on the Award of Credit Points
6	Requirements on the Award of Credit Points
6	Requirements on the Award of Credit Points
6 7	Grading
	Grading Final Module Examination:
	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Grading Final Module Examination:
	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
7	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module
7	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math:
7	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module
8	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2
7	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature
8	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser
8	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg
8	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis II, Springer
8	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis II, Springer K. Königsberger: Analysis 1, 2, Springer
8	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis II, Springer
8	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis II, Springer K. Königsberger: Analysis 1, 2, Springer
7 8 9	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis I, Springer K. Königsberger: Analysis 1,2, Springer W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
8	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis II, Springer K. Königsberger: Analysis 1, 2, Springer
7 8 9	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Usability of the Module Für B.Sc.MCS, B.Sc.M\amp;E,: Pflicht Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, LaG.Math: als Alternative zu Analysis 2 Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis I, Springer K. Königsberger: Analysis 1,2, Springer W. Rudin: Principles of Mathematical Analysis, McGraw-Hill

	Linea	r Algeb	ra 1								
Мо	dule no.	Credit F	Points	Workload	Self-study	Duration		Frequency			
04-	00-0005		9 CP	270 h	165 h	165 h 1 Semester Every 2. seme					
Lan	guage of	Instruct	ion		Person responsib	le for the	Modu	le			
Ger	man				Prof. Dr. rer. nat. Martin Otto						
1	Course	s of the	Module								
	Course	no.	Course name		Workload (CP)		Teaching H		Contact Hours per Week		
	04-00-0042-tt		Linear A	gebra I	0	C	Conver	ntion	1		
	04-00-0	042-vu	Linear A	gebra I	0		ecture Exercis		6		
3	Die Studierenden können die Konzepte der linearen Algebra in verschiedenen Zusammenhängen erkennen, anwenden und erklären. Sie lernen insbesondere, abstrakt- axiomatisch Begriffsbildungen der linearen Algebra auf einschlägige Probleme anzuwenden, geometrischen Begriffen in Verbindung zu bringen, typische Aufgaben zu lösen und einfache Beweise zu führen.						venden, mi				
4	-			ipation							
	keine	ements f f Examir odule E>	or Partic		amination, oral / w	vritten Exa	minat	ion, St			
4 5 6	keine Form o Final M	ements f f Examir odule Ex Module	for Partic nation caminatic e Examir	on:		vritten Exa	minat	ion, St			

• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
Usability of the Module
Grundstudium Mathematik
Literature
Bosch: Lineare Algebra
Brieskorn: Lineare Algebra und Analytische Geometrie
Bröcker: Lineare Algebra und Analytische Geometrie
Fischer: Lineare Algebra
Greub: Linear Algebra (auch deutsch)
Koecher: Lineare Algebra und Analytische Geometrie
Comment

	Linea	ar Algeb	ora 1							
Мо	dule no.			Workload	Self-	Self-study Duratio		n Frequer		ency
04-(00-0006		9 CP	270 h		165 h 1 Semes				2. semester
Lan	guage of	Instruct	tion		Pers	on responsib	le for the	e Modu	ule	
Eng	lish				Prof	. Dr. rer. nat.	Martin O	tto		
1	Course	s of the	Module							
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0041-tt Lin		Linear A	Linear Algebra I		0		Convention		1
	04-00-0	04-00-0041-vu Linear A		gebra I		0		Lecture and Exercise		6
2	-	Study Content basic notions and concepts, algebraic structures (groups, rings, fields);								
	vector	vector spaces, linear dependence, bases, dimension;								
	linear a	nd affin	e subspa	ces, products, sum	s and	quotients, du	al space;			
	linear n	naps and	d matrice	s;						
	determ	inants								

	systems of linear equations
3	Learning Outcomes Students will be able to recognise the concepts of linear algebra in various contexts, and to apply and explain them. In particular, they will have learnt to apply abstract-axiomatic notions of linear algebra to typical problems, to connect them with geometric concepts, to solve typical problems and to conduct simple proofs.
4	Requirements for Participation keine
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Grundstudium Mathematik
9	Literature Bosch: Lineare Algebra Brieskorn: Lineare Algebra und Analytische Geometrie Bröcker: Lineare Algebra und Analytische Geometrie Fischer: Lineare Algebra Greub: Linear Algebra (auch deutsch) Koecher: Lineare Algebra und Analytische Geometrie
10	Comment

Module name Linear Algebra 2

	dule no.	Credit F		Workload			study		Durati		Frequ	-			
	00-0007		9 CP		270 h				1 Seme		· ·	2. semester			
	guage of	Instruct	tion				Person responsible for the Module								
Geri	man					Prof	. Dr. rer. n	nat.	Martin	Otto					
1	Course	s of the	Module												
	Course	no.	Course name				Workloa	nd (0	CP)	Form Teac	-	Contact Hours per Week			
	04-00-0	008-tt	Linear Algebra II				0			Conve	ntion	1			
	04-00-0008-vu Linear Algebra II						0			Lectur Exerci:		6			
2	Study C			alisation of e											
	Jordan euclide bilinear possible	characteristic an minimal polynomials in the ring of univariate polynomials; Jordan normal form; euclidean and unitary spaces; bilinear forms, quadratic forms, quadrics; possible excursions: affine and projective geometry, geometry of conic sections, or elements of multilinear algebra													
3	Die Stu Algebra Begriffs	und erf bildunge	en erlern ahren da en der Al	ien zentrale I as Zusammer Igebra und ih n Anknüpfun	nspiel z nrer Rol	wisch lle in d	en abstra diversen B	kt-a Bere	axiomat eichen d	ischen	nematik	.,			
4	-	ements f Algebra	f or Parti o 1	cipation											
5			kaminatio	on: nation (Techr	nical Exa	amina	ation, oral	/ w	vritten E	Examina	tion, St	andard)			
6	Require	ements o	on the A	ward of Crec	dit Poin	its									
7	Gradinı Final M	odule Ex		on: nation (Techr	nical Ex	amina	ation, oral	/ w	vritten E	Examina	tion, W	eight: 100%,			

8	Usability of the Module Grundstudium Mathematik
9	Literature Bosch: Lineare Algebra Brieskorn: Lineare Algebra und Analytische Geometrie Bröcker: Lineare Algebra und Analytische Geometrie Fischer: Lineare Algebra Greub: Linear Algebra (auch deutsch) Koecher: Lineare Algebra und Analytische Geometrie
10	Comment

Мо	dule nam	ne											
	Linea	r Algeb	ra 2		Γ				T				
Мо	dule no.	Credit F	Points	Workload		study	Duration	า	Freque	ency			
04-	00-0008		9 CP	270 h	165 h 1 Semester Every 2					2. semester			
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ıle				
Eng	lish				Prof	. Dr. rer. nat.	Martin O	tto					
1	Course	Courses of the Module											
Course						Workload (CP)		Form of Teaching		Contact Hours per Week			
	04-00-0	04-00-0012-tt		Linear Algebra II				Conve	ntion	1			
	04-00-0	012-vu	Linear A	gebra II		0			e and se	6			
2	Study Content eigenvalues and diagonalisation of endom characteristic an minimal polynomials in t Jordan normal form; euclidean and unitary spaces; bilinear forms, quadratic forms, quadrics; possible excursions: affine and projective or elements of multilinear algebra					of univariate			ns,				

3	Learning Outcomes
	Students will be able to recognise the concepts of linear algebra
	in various contexts, and to apply and explain them.
	In particular, they will have learnt to apply abstract-axiomatic
	notions of linear algebra to typical problems, to connect
	them with geometric concepts, to solve typical problems and to
	conduct simple proofs.
4	Requirements for Participation
	Lineare Algebra 1
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	A Madula Evaniantian (Task rice) Evanination, and (written Evanination, Maisht, 100%
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Stendard)
	Standard)
8	Usability of the Module
	Grundstudium Mathematik
9	Literature
	Bosch: Lineare Algebra
	Brieskorn: Lineare Algebra und Analytische Geometrie
	Bröcker: Lineare Algebra und Analytische Geometrie
	Fischer: Lineare Algebra Greub: Linear Algebra (auch deutsch)
	Koecher: Lineare Algebra und Analytische Geometrie
10	Comment

Module nam	Module name											
Ordiı	Ordinary Differential Equations											
Module no.	Credit Points	Workload		Self-study		Duration	Frequency					
04-00-	4 CP		120 h		75 h	1 Semester	Every 2. semester					

001	1/f									
Lang	guage of In	struction			Pers	on responsit	le for th	e Modu	le	
Geri	man				Prof.	Dr. rer. nat.	Matthias	s Hieber		
1	Courses o	of the Moo	dule							
	Course no	o. Co	urse name	•		Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-00-0054	4-vu Ord	linary Differ	ential Equatior	าร	0		Lecture Exercise		3
2	global the	n of varial ory, linea	r systems o	ems of Picard of first and hig yapunov stabi	gher o					
3	Learning (Nach dem		s les Moduls							
	- sind sie r - sind sie r vertraut - können s - können s	mit den Sä mit der lol sie lineare Sie die Vai sie das Pri	itzen von F kalen und g e Systeme e riation der nzip linear	Trennung der Picard-Lindelö globalen Exist erster und höł konstanten F isierter Stabili apunov Stabil	f und enzth herer ormel ität fo	Peano vertra eorie gewöh Ordnung ana entwickeln rmulieren ur	nlicher D Ilysieren nd anwer	nden	-	
4	-		Participatic s und Linea	o n are Algebra (fi	ür Phy	vsikstudieren	de)			
5	Form of E Final Mod									
	• N	/lodule Exa	amination	(Technical Exa	amina	tion, oral / w	vritten Ex	aminati	ion, St	andard)
	only a sma an oral ex	all numbe am (20 mi e first two	r of potent in). The de	n is taken in fe tial participan cision about t the lecture, ba	ts. In t te foi	this case, the rm of the exa	e exam ca am is take	an be tal en and c	ken in t commu	the form of inicated
6	Requirem Bestehen			of Credit Poin	its					
7	Grading		-							

	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Bachelor Physics
9	Literature H. Amann: Gewöhnliche Differentialgleichungen, de Gruyter W.Walther: gew. DGL, Springer
10	Comment

Mo	dule nan	ne												
	Com	plex An	alysis											
Mo 04-0 001		Credit Points 4 CP		Workload	120 h	Self-	e lf-study 75 h		Duration 1 Semester		Freque Every 2	ncy . semester		
	guage of man	Instruct	ion			Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber								
1	Course	Courses of the Module												
	Course no.		Course	urse name			Workload (CP)		CP)	Form of Teaching		Contact Hours per Week		
	04-00-0	04-00-0225-vu Comple		x Analysis			0			Lecture and Exercise		3		
2	Theore Theore	-Rieman m and Fo	ormula; a ebra; Wi	ntial equation analyticity, Lio nding Numbe	ouville	's The	orem and	d Fu	ndament	al	es,			
3 Learning Outcomes Nach dem Besuch des Moduls														
	- könne	- sind sie mit den Cauchy-Riemannschen Differentialgleichungen vertraut - können sie Kurvenintegrale analysieren und berechnen - sind sie mit dem Cauchyschen Integralsatz und der Cauchyschen Integralformel												

	vertraut und können deren Implikationen aufzeigen - sind sie mit der Bedeutung der Potenzreihen in der Funktionentheorie vertraut - können sie den Satz von Liouville und den Hauptsatz der Algebra erklären - können sie Laurentreihen analysieren - können sie isolierte Singularitäten anhand konkreter Beispiele erklären
	- sind mit dem Residuensatz und dessen Implikationen vertraut
4	Requirements for Participation Analysis and Linear Algebra
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung: Usually the exam is taken in form of a written test (60 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of
	an oral exam (20 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Bachelor Physics
9	Literature Freitag: Funktionentheorie I, Springer Remmert: Funktionentheorie I, Springer Conway: Functions of one complex variable, Springer
10	Comment

Module name

Proseminar

Mo	dule no.	Credit F	Points	Workload		Self-	study		Duration	1	Freque	ency		
04-0	00-0025		4 CP		120 h		90	0 h	1 Semes	ter	Every	2. semester		
Lan	guage of	Instruct	ion	•		Pers	on respor	nsib	le for the	e Modu	ule			
Ger	man					Stud	iendekan	*in	des Fach	bereich	าร 04			
1	Course	s of the I	Module											
	Course	no.	Course name				Workload (CP)			Form Teach	-	Contact Hours per Week		
	04-00-0	047-ps	Prosemi	nar			0			Prosen	ninar	2		
2	Study Content A simple topic is assigned to individual students or to small groups of students. The subject matter may vary with the instructor's choice of a general theme. The seminar may have a project format. Each participant gives a one hour presentation to the seminar.													
3	Learning Outcomes Die Studenten können eine Literaturrecherche durchführen, sich ein mathematisches Thema im Selbststudium aneignen und dieses in einem Vortrag anschaulich präsentieren. Gegebenenfalls können sie den Sachverhalt auch schriftlich angemessen darstellen.													
4	-		or Partio neare Alg	-										
5		 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) 												
		form: In	der Rege	el eine Präs nnt gegebe	entation					-		1)		
6	Require	ements o	on the A	ward of Cre	edit Poin	ts								
7	Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)													
8		-	Module B.Sc.WiN	e ⁄Ia, B.Sc.MC	S, B.Sc.N	ME: P	flicht							
9	Literatu wird je		ema ang	egeben										

Мо	dule nam	ne											
	Prose	eminar											
Мо	dule no.	Credit F	oints	Workload	Self-study		Duration	า	Frequ	ency			
04-	00-0026		4 CP	120 h	90) h	1 Semes	ter	Every	2. semester			
Lan	guage of	Instruct	ion		Person respon	sib	le for the	Modu	ıle				
Eng	lish				Studiendekan*	*in (des Fachl	pereich	ns 04				
1	Course	s of the I	Module										
	Course	no.	Course	name	Workloa	Workload (CP)			of Iing	Contact Hours per Week			
	04-00-0	147-ps	Prosemi	nar	0			Prosen	ninar	2			
 The subject matter may vary with the instructor's choice of a general theme. The seminar may have a project format. Each participant gives a one hour presentation to the seminar. Learning Outcomes In der Vorbereitungsphase: F\u00e4higkeit zu Literaturrecherche, Selbststudium, Auswahl der Pr\u00e4sentationstechniken, Arbeitsorganisation. Beim Vortrag: F\u00e4higkeit zu anschaulicher Darstellung durch freie Rede, Erfahrung beim Einsatz von Pr\u00e4sentationstechniken, F\u00e4higkeit, auf die Zuh\u00f6rer einzugehen. Von Seiten der H\u00f6rer: Bef\u00e4higung zu aktiver und fairer Diskussion \u00fcber Inhalte 													
4	Darstellung der Ergebnisse. Requirements for Participation Analysis 1,2 und Lineare Algebra 1,2												
5		Form of Examination Final Module Examination:											
	 Module Examination (Study Examination, Special Form, Passed / Not Passed) Sonderform: In der Regel eine Präsentation. Die Prüfungsform wird zu Beginn der Lehrveranstaltung bekannt gegeben. 												

6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.WiMa, B.Sc.MCS, B.Sc.ME: Pflicht
9	Literature wird je nach Thema angegeben
10	Comment Verantwortlich: Studiendekan

Mo	dule nam	ne									
	Intro	duction	n to Mat	hematical Logic							
Mo	dule no.	Credit I	Points	Workload	Self	-study	Duratio	n Freque		ncy	
04-0	00-0028		9 CP	270 h	1	180 h	1 Semes	ter	Every 2	. semester	
Lan	guage of	Instruct	tion		Pers	son responsib	le for th	e Modu	ule		
Eng	lish				Prof	. Dr. phil. nat	. Ulrich K	ohlenb	ach		
1	Course	s of the	Module								
	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week	
			Introduc Logic	roduction to Mathematical gic		0		Lecture and Exercise		6	
2	Study C	Content									
	theorer logical	n; compa and set-f	actness t theoretic	first-order logic; for heorem, foundations of ma idability and incom	athem	atics; elemen		calculi;	; comple	teness	
3	Learnin	Learning Outcomes									
	the stu	dents ar	e familia	r with basic concep	ots and	d methods fro	om mathe	ematica	al logic a	nd can use	
	them ir	hthe cor	ntext of c	lassical theorems f	or firs	t-order logic	and in co	nnecti	on with	the concept	
	of form	al proof	s. They k	now the significan	ce of f	irst-order log	ic in the	founda	tions of		

	mathematics and can also discuss the limitations of first-order logic referring to the relevant theorems.
4	Requirements for Participation solide allgemeine mathematische Vorbildung
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.MCS: A* Für B.Sc.WiMa, B.Sc.ME: math Wahlpflichtbereich Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich
9	Literature exemplarisch, neben vielen anderen Lehrbüchern: Ebbinghaus, Flum, Thomas: Einführung in die mathematische Logik; Shoenfield: Mathematical Logic; Cori, Lascar: Mathematical Logic; Poizat: A Course in Model Theory, an Introduction to Contemporary Mathematical Logic
10	Comment

Мос	Module name											
	Algel	ora										
Мос	ule no. Credit Points Workload		Self-study Duration		l I	Frequency						
04-0	-00-0029 9 CP 270 h				270 h		180 h	1 Semester Every 2. semes			semester	
Lang	guage of	Instructi	on			Perso	on responsib	le for the	Modu	le		
Gerr	man					Prof. Dr. rer. nat. Nils Scheithauer						
1	Course	s of the N	/lodule			,						
Course no. Course name Workload (C							CP)	Form	of	Contact		

				Teaching	Hours per Week						
	04-00-0080-vu	Algebra	0	Lecture and Exercise	6						
2	Study Content Rings, polynom	ial rings, field extensio	ons, Galois theory, modu	ules							
3	-	the module, students	understand the basic collected and master the theory		•						
4	Requirements for Participation Einführung in die Algebra										
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) 										
6	Requirements	on the Award of Cred	it Points								
7	Grading Final Module Ex • Modul Standa	e Examination (Techni	ical Examination, oral / v	written Examination, Wo	eight: 100%,						
8		B.Sc.Math (bilingual), eich. Für M.Sc.Math: \	B.Sc.MCS, B.Sc.WiMa, B /ertiefungsbereich. Für I								
9	Literature Jantzen, Schwermer: Algebra, Bosch: Algebra, Lang: Algebra, Hungerford: Algebra										
10	Comment										

	Algel	bra										
	odule no.		Points 9 CP	Workload 270 h		Self-studyDurationFrequency180 h1 SemesterEvery 2. ser				•		
	iguage of	Instruct				on responsib			-			
	glish					Dr. rer. nat.						
1	Course	s of the	Module									
	Course no.		Course name			Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-00-0	149-vu	Algebra			0		Lecture Exercis		6		
	Field ex Galois t Module	es	s,									
3	After at	sight int	the mod	lule, students unde eory of modules an			-	-		-		
4	-		f or Partic e Algebra	c ipation a, Einführung in die	Algeb	ora						
	Form of Examination Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Standard)											
5		Modul	e Examir	iation (Technical Ex	amma	ition, oral / w	ritten Ex	aminat	tion, Sta	andard)		
				ward of Credit Poir		ation, oral / w	vritten Ex	aminat	ion, Sta	andard)		
5 6 7	Require	ements o		ward of Credit Poir		ition, oral / w	vritten Ex	aminat	ion, Sta	andard)		

8	Usability of the Module Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.MCS, B.Sc.WiMa, B.Sc.ME: Wahlpflichtbereich. Für M.Sc.Math: Vertiefungsbereich. Für M.Sc.WiMa: Ergänzungsbereich.
9	Literature Jantzen, Schwermer: Algebra, Bosch: Algebra, Lang: Algebra, Hungerford: Algebra
10	Comment

Мо	dule nan	-									
	Discr	ete Ma	themati	cs	1		1				
Мо	dule no.	Credit F	Points	Workload	Self-stu	ıdy	Duratio	n	Freque	ncy	
04-	00-0034		9 CP	270 h		180 h	1 Semes	ter	Every 2	. semeste	
Lan	guage of	Instruct	ion		Person	responsib	le for the	e Modu	ule		
Ger	man				Prof. D	r. rer. nat.	Marc Pfe	tsch			
1	Course	Courses of the Module									
	Course no.		Course	name	Workload (CP)	CP) Form of Teaching		Contact Hours per Week	
	04-00-0	137-vu	Discrete	Mathematics	0	0		Lecture and Exercise		6	
2	Permut graphs series C regular	y ordere ation gro projectiv Other top tilings o	oups: gro ve planes pics (sele f the pla	attices, Möbius func oup actions on (finit s Generating functio ction): triangulatior ne; graph coloring; ymmetric group	e) sets a ons: solv ns of con	nd graphs ing recursi ivex polyge	, Cayley ons, hype ons;	ergeon			
3	After at o recog o unde	Learning Outcomes After attendance of the module, the students are able to o recognize discrete structures with far reaching relations to other fields of mathematics, o understand general foundations for algorithmic concepts, o apply different concepts of counting.									

4	Requirements for Participation
	Algorithmic discrete mathematics
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
9	Literature
	M. Aigner, Diskrete Mathematik, 5. Auflage, Vieweg, 2003.
	M. Aschbacher, Finite Group Theory, Cambridge, 1986. N. Biggs, Algebraic Graph Theory, Second Edition, Cambridge, 1993.
	R. L. Graham, D. E. Knuth and O. Patashnik, Concrete Mathematics, Second
	edition, Addison-Wesley, Reading, MA, 1994.
	W. Koepf, Hypergeometric Summation. An Algorithmic Approach to Summation
	and Special Function Identities, AMS, 1998.
	J. Matoušek, J. Nešetril, Diskrete Mathematik. Eine Entdeckungsreise,
	Springer, 2002. R.P. Stanley, Enumerative Combinatorics, Volume I, Cambridge 1997.
10	Comment

Мос	Module name											
Functional Analysis												
Мос	Nodule no. Credit Points Workload			Self-study Duration		1	Frequency					
04-0	0-0036		9 CP		270 h		180 h	1 Semest	ter	Every 2. semester		
Lang	guage of	Instructi	on			Person responsible for the Module						
Gerr	man					Prof. Dr. rer. nat. Matthias Hieber						
1	Course	s of the N	Aodule									
	Course no. Course name						Workload (CP)	Form	of	Contact	

					Teaching	Hours per Week					
	04-00-0069-vu	Functional Analysis	0		Lecture and Exercise	6					
2	Study Content normalised spaces; completion; Hahn-Banch theorem; theorems of Banach-Steinhaus, of the open mapping, of the closed graph; Hilbert spaces; reflexive spaces; weak convergence; Sobolev spaces; weak solution of the Dirichlet problem; spectral properties of linear operators; compact operators on Banach spaces; spectral theorem for compact operators.										
3	- combine ideas - determine the exemplarily	mes the module, students will b of linear algebra, analysis a interaction of space and du onal analytical methods in th	ind topology ial space and in								
4	Requirements for Participation Analysis, Integrationstheorie, Funktionentheorie, Lineare Algebra oder vergleichbare Vorkenntnisse aus einem Zyklus Mathematik für Ing.										
5	Form of Examin Final Module Ex • Module		amination, oral	l / written Exa	amination, Sta	indard)					
6	Requirements o	on the Award of Credit Poir	its								
7	Grading Final Module Ex • Module Standar	e Examination (Technical Ex	amination, oral	l / written Exa	amination, We	ight: 100%,					
8	for M.Sc.Math,	Module B.Sc.MCS, B.Sc.WiMa, B.Sc.M M.Sc.WiMa: supplementary try/functional analysis is rec	v area in partial		equations and	in					
9	Heuser: Funktio	se in Functional Analysis; nalanalysis; Inctional Analysis: Methods al Analysis;	of Modern Ma	thematical Pl	hysics I;						

Мо	dule nam	ne										
	Elem	entarv	Partial [Differential Equat	ions							
Мо	dule no.			Workload		study	Duration	า	Freque	ency		
04-0	00-0039		6 CP	180 h		120 h	1 Semes	ter	Every 2	2. semester		
Lan	guage of	Instruct	ion		Person responsible for the Module							
Ger	man				Prof	. Dr. rer. nat.	Jens Lang	B				
1	Course	s of the I	Module			I						
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week		
					Lecture Exercis		4					
	physica elliptic	l interpr different	etation; tial equa	ions of the wave eq fundamental solutio tions, maximal prin al dommains	ons ai	nd reen's fun	ction for					
3		g Outco em Besu		Ioduls können die S	tudie	renden						
	 die Grundtypen linearer partieller Differentialgleichungen mit klassischen und expliziten Lösungsmethoden untersuchen 											
		- Mathematische Modelle zur Behandlung grundlegender naturwissenschaftlicher und technischer Problemstellungen aufstellen und analysieren										
4	-	e: Analys	or Partic	ipation neare Algebra, gewo	öhnlio	che Differenti	algleichu	ngen,				
5		f Examin										
		 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) 										

6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Für B.Sc.CE: Pflicht
9	Literature John: Partial Differential Equations Jost: Partielle Differentialgleichungen Strauss: Partielle Differentialgleichungen Sauvigny: Partielle Differentialgleichungen der Geometrie und Physik. Band 1: Grundlagen und Integraldarstellungen
10	Comment

Мос	Module name											
	Intro	duction	to Opt	imization								
Мос	dule no.	Credit F	Points	Workload		Self-	study	Duratio	n	Freque	ency	
04-0	04-00-0040 9 CP 270 H			270 h		180 h	1 Semes	ter	Every	2. semester		
Lang	guage of	Instruct	ion			Pers	on responsib	le for the	e Modu	ule		
Gerr	German					Prof.	Dr. rer. nat.	Marc Pfe	etsch			
1 Courses of the Module												
	Course no. Course		Course	name		Workload (CP)		Form Teacł	-	Contact Hours per Week		
	04-00-00)23-vu	Introduc	tion to Optimiz	zation		0		Lectur Exercis		6	
2	Study Content convex sets and functions; introduction to polyhedral theory; optimality and duality theory of linear optimization; simplex-algorithm for the solution of linear optimization problems; polynomial complexity of linear optimization; methods for quadratic optimization problems								ns;			
3	Learnin	g Outco	mes									
	After at	tendand	e of the	module, the s	studen	its are	able to hand	dle optim	ality a	nd duali	ity theory of	

10	Comment
	Ziegler: Lectures on Polytopes
	Schrijver: Theory of Linear and Integer Programming;
	Nocedal; Wright: Numerical Optimization;
	Jarre, Stoer: Optimierung
	Geiger; Kanzow: Theorie und Numerik restringierter Optimierungsaufgaben;
9	Literature Chvatal: Linear Programming
8	Usability of the Module Für B.Sc.WiMa, B.Sc.Mamp;E: Pflicht Für B.Sc.Math, B.Sc.MCS: Wahlpflichtbereich Mathematik (C*) Für M.Sc.Math: Ergänzungsbereich Für B.Sc.CE: als mathematisches Wahlmodul wird in der Mastervertiefung Optimierung vorausgesetzt
	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
7	Grading
6	Requirements on the Award of Credit Points
	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
5	Form of Examination
4	Requirements for Participation Module: Analysis und Lineare Algebra
	of convex functions. They know the fundamental numerical solution methods for linear and quadratic optimization problem. They can model and solve linear and quadratic optimization problem arising from a practical context.
	linear optimization and can apply them. They are familiar with polyhedral theory and the theo

Module name

	Prob	ability 1	Theory								
	dule no.)0-0045	Credit F	Points 9 CP	Workload	270 h	Self-	study 180 h	Duration 1 Semes		Freque Every 2	e ncy 2. semester
Lang Gerr	guage of man	Instruct	ion			Person responsible for the Module Prof. Dr. rer. nat. Frank Aurzada					
1	Courses of the Module										
	Course	no.	Course name				Workload (CP)			of ing	Contact Hours per Week
	04-00-0141-vu Probability Theory						0		Lecture Exercise		6
2	Study Content Measure theoretical foundations, theory of integration, random variables, concepts of convergence, characteristic functions, stochastic independence, 0-1-laws, conditional expectations, martingales in discrete time, limit theorems: law of large numbers, central limit theorem										
 3 Learning Outcomes After completion of this module, the students are expected to - know the basic concepts and constructions of measure theory and probability theory, - be able to apply these concepts to simple models, - know the central results of probability theory and are able to describe their consequences in simple models, - are able to model random phenomena mathematically. 											
4	-		or Partic is, Integr	c ipation ration, Einfü	ihrung iı	n die S	Stochastik				
5			aminatio		nical Ex	amina	ition, oral / w	vritten Ex	aminati	ion, St	andard)
6	Require	ements o	on the A	ward of Cre	dit Poin	ts					
7	Grading Final M	odule Ex			nical Ex	amina	ition, oral / w	vritten Ex	aminati	ion, We	eight: 100%,
8		Usability of the Module Für B.Sc.WiMa, B.Sc.M\amp;E: Pflicht									

 Für B.Sc.Math, B.Sc.MCS: Wahlpflichtbereich Mathematik (D*)

 Für M.Sc.Math: Ergänzungsbereich

 Für B.Sc.CE: im mathematischen Wahlpflichtbereich A

 Für M.Sc.CE: Bereich 1B wird in der Mastervertiefung Stochastik vorausgesetzt.

 9
 Literature

 Bauer: Probability Theory

 Billingsley: Probability and Measure

 Elstrodt: Maß-und Integrationstheorie

 Gänssler, Stute: Wahrscheinlichkeitstheorie

 Klenke: Wahrscheinlichkeitstheorie

 Verantwortlich: Herr Aurzada (sto)

Mod	lule nan	ne									
	Prob	ability 1	Theory								
Mod	lule no.	Credit I	Points	Workload		Self-	study	Duratio	n	Freque	ency
04-0	0-0046		9 CP	2	270 h		180 h	1 Semes	ster	Every	2. semester
Lang	guage of	Instruct	tion			Pers	on responsib	le for th	e Modu	ule	
Engl	ish					Prof	. Dr. rer. nat.	Frank Au	ırzada		
1	Course	s of the	Module								
			Course	se name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	071-vu	Probabil	ity Theory			0			e and Se	6
2	Study C	Content									
	Study Content Measure theoretical foundations, theory of integration, random variables, concepts of convergence, characteristic functions, stochastic independence, 0-1-laws, conditional expectations, martingales in discrete time, limit theorems: law of large numbers, central limit theorem.										
3	Learnir	ng Outco	mes								
	Nach d	em Besu	ch des N	1oduls können	n die S	tudie	renden				
		•		nzepte und Ko nfachen Mode				und Wah	rschein	llichkeit	tstheorie

	 die zentralen Ergebnisse der Wahrscheinlichkeitstheorie und ihre Konsequenzen beschreiben und in einfachen Modellen anwenden,
	- zufällige Phänomene mathematisch modellieren und analysieren.
4	Requirements for Participation Module: Analysis, Integration, Einführung in die Stochastik
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Für B.Sc.WiMa, B.Sc.ME: Pflicht Für B.Sc.Math, B.Sc.MCS: Wahlpflichtbereich Mathematik (D*) Für M.Sc.Math: Ergänzungsbereich Für B.Sc.CE: im mathematischen Wahlpflichtbereich A Für M.Sc.CE: Bereich 1B wird in der Mastervertiefung Stochastik vorausgesetzt.
9	Literature Bauer: Probability Theory Billingsley: Probability and Measure Elstrodt: Maß-und Integrationstheorie Gänssler, Stute: Wahrscheinlichkeitstheorie Klenke: Wahrscheinlichkeitstheorie
10	Comment Verantwortlich: Herr Aurzada (sto)

Module nam	Module name										
Proje	Project in Mathematics										
Module no.	Credit Points	Workload		Self-study		Duration	Frequency				
04-00-0053	6 CP		180 h		180 h	1 Semester	Every 2. semester				

	iguage of Instruc rman	tion	Person responsible for the Module Studiendekan*in des Fachbereichs 04								
1	Courses of the	Module	1								
-	Course no.	Course name		Workload (CP)	Form of Teaching	Contact Hours per Week					
2	Study Content A small group works on a complex problem. The formulation of the problem may be open ended; a final precise and focussed fomulation may be a part of the project. The concrete subject matter content will depend on the problem. Regular reports describe the work in progress. In conclusion, there will be a presentation in which the results are described and discussed. A report in writing, preferably in LATEX, will record and document the results of the project.										
3	Learning Outcomes Die Studierenden können für eine konkrete Problemstellung Lösungsstrategien entwickeln und umsetzen. Sie können eine umfangreiche Aufgabe in Teilschritte gliedern, Zwischenzielen formulieren, sinnvolle Teilaufgaben definieren, und geeignet präsentieren. Je nach Thema können sie auch experimentell arbeiten und Software anwenden.										
4	Requirements nach Angabe	for Participation									
5	Form of Exami Final Module E • Modu		inatior	n, Special Form, Pa	ssed / Not Passe	d)					
6	Requirements	on the Award of Credit Poi	nts								
7	Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)										
8	Usability of the Für B.Sc.Math, einer Bachelor	B.Sc.WiMa, B.Sc.MCS, B.Sc.	ME: al	ternativ zum Semir	nar. Kann als Aus	gangspunkt					
9	Literature										

	je nach Thema
10	Comment
	Verantwortlich: Studiendekan

Мо	dule nan	ne							
	Proje	ect in Ma	athema	tics					
Мо	dule no.	Credit P	oints	Workload	Self-study Dura		1	Frequency	
04-(00-0054		6 CP	180 h	180 h	1 Semest	ter	Every 2	. semester
Lan	guage of	Instruct	ion		Person responsib	le for the	Modu	ule	
Eng	lish				Studiendekan*in	des Facht	pereich	ns 04	
1	Course	s of the I	Module						I
	Course	Course no. Course name			Workload (CP)		Form of Teaching		Contact Hours per Week
2	Study Content A small group works on a complex problem. The formulation of the problem may be open ended; a final precise and focussed fomulation may be a part of the project. The concrete subject matter content will depend on the problem. Regular reports describe the work in progress. In conclusion, there will be a presentation in which the results are described and discussed. A report in writing, preferably in LATEX, will record and document the results of the project.								
3	Lösung Projekt von Au	manager fgaben a	en für ko ment: Gl n die Tea	onkrete Problemste iederung in Teilschr am-Mitglieder, Ausv celles Arbeiten und	itte, Formulierung wahl geeigneter Pr	von Zwis äsentatio	chenzi nstech	nniken, jo	e nach
4	Require	ements f ngabe	or Partio	ipation					
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) 								
6	Require	ements c	on the Av	ward of Credit Poin	ts				

7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module Für B.Sc.Math, B.Sc.WiMa, B.Sc.MCS, B.Sc.ME: alternativ zum Seminar. Kann als Ausgangspunkt einer Bachelorarbeit dienen.
9	Literature wird je nach Thema spezifiziert
10	Comment Verantwortlich: Studiendekan

Mod	lule nam	ne								
	Appli	ied Proc	of Theo	Ϋ́Υ	_					
Мос	lule no.	Credit F	Points	Workload	Self-study Duration		า	n Frequency		
04-0	0-0058		9 CP	270 h		180 h	1 Semes	ter	Every 2.	semester
Language of Instruction English						on responsib . Dr. phil. nat				
1	Courses	s of the	Module							
	Course no.		Course	name	Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-03	166-vu	Applied	Proof Theory		0	Lecture and Exercise		6	
2 Study Content This course gives an introduction to the area of applied proof theory. The course focuses on called proof interpretations which extract computational data from (even prima facie ineffective) proofs by recursion on the proof. Table of contents: no-counterexample interpretation, intuitionistic logic, negative translation, Gödel functional interpretation, monotone functional interpretation, elimination of König's lemma, applications to proofs in analysis.						۱,				
3	Introdu		one of t	ne active research a theoretic resp. cate			ic with a	particı	ular empł	nasis on

-							
4	Requirements for Participation						
	Einführung in die mathematische Logik Nützlich: Introduction to Computability Theory.						
5	Form of Examination						
	Final Module Examination:						
	• Module Examination (Technical Examination, oral / written Examination, Standard)						
6	Requirements on the Award of Credit Points						
7	Grading						
	Final Module Examination:						
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)						
8	Usability of the Module						
	Für M.Sc.Math: zusammen mit passender Ergänzung als Vertiefung Logik Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich						
9	Literature						
	Kohlenbach, Ulrich: Proof Interpretations and the Computational Content of Proofs. Lecture notes (320pp). Draft of book project.						
10	Comment						

Module name											
Discrete Optimization											
Module no. Credit		Credit F	Points Workload		Self-study		Duration		Frequency		
04-00-0073			9 CP	270 h	180 h 1 Sem		1 Semes	Semester		Every 2. semester	
Language of Instruction Person responsible for the Module											
German P						Prof. Dr. rer. nat. Marc Pfetsch					
1	Courses of the Module										
	Course no. Course		name		Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-00-0	027-vu	Discrete	Optimization		0		Lecture Exercis		6	
2	Study C	Study Content									
	modeling; integral equation and inequality systems; theory: integer programs, polyhedral										

	combinatorics; methods: exact solution methods, approximation algorithms, heuristics, relaxations
3	Learning Outcomes After attendance of the module, the students are able to handle the theoretical foundations of discrete optimization. The students additionally are able to model problems and analyze and apply relevant algorithms.
4	Requirements for Participation Introduction to Optimization, Algorithmic Discrete Mathematics
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M.Sc.Math, M.Sc.WiMa: Vertiefung Optimierung M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich M.Sc.CE: B2
9	Literature Nemhauser, Wolsey: Integer and Combinatorial Optimization Schrijver: Theory of Linear and Integer Programming
10	Comment

Module name									
Project in Mathematics (Master)									
Module no.	Credit Points	Workload		Self-study	Duration	Frequency			
04-00-0080	6 CP	18	80 h	180 h	1 Semester	Every 2. semester			
Language of	Instruction			Person responsible for the Module					
German				Studiendekan*in des Fachbereichs 04					

1	Courses of the	Module			
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
2	ended; a final p subject matter progress. In cor	recise and focussed fomula content will depend on the nclusion, there will be a pre	n. The formulation of the p ation may be a part of the p e problem. Regular reports esentation in which the resu n LATEX, will record and do	project. The cor describe the wo ults are describe	ocrete ork in ed and
3	Sie können eine Zwischenzielen und geeignet pi	en können für Problemstellung Lösungsstr e umfangreiche Aufgabe in formulieren, sinnvolle Teil räsentieren. können sie auch experime	aufgaben definieren,	isetzen.	
4	Requirements f	for Participation			
5		kamination: e Examination (Study Exam	ination, Special Form, Pas	sed / Not Passe	d)
6	Requirements	on the Award of Credit Poi	nts		
7	Grading Final Module Ex Modul Passed	e Examination (Study Exam	ination, Special Form, Wei	ght: 100%, Pass	ed / Not
8			.M\amp;E: alternativ zum S en.	eminar. Kann a	ls
9	Literature je nach Thema				
10	Comment				

Mod	lule nam	ie									
	Proje	ct in M	athema	tics							
Mod	lule no.	Credit F	oints	Workload	Self-	study	Duratio	า	Freque	ency	
04-0	0-0081		6 CP	180 h	180 h 1 Semester Every 2. se				2. semester		
Language of Instruction						Person responsible for the Module					
Engl	ish				Stud	iendekan*in	des Fach	bereicł	าร 04		
1	Courses	s of the l	Module		•						
	Course no. Course name			name		Workload (CP)	-	Form of Co Teaching Ho pe W		
2	formuli fachlich regelmä vorgest	mplexe I ert sein en Inhal äßig beri ellt und	und erst te sind t chtet. D diskutie	stellung wird durch während der Bearb hemenabhängig. Ül en Abschluss bildet rt werden. Gegeben Il ein wissenschaftlic	eitun per de eine l enfal	g präzisiert o en Fortgang o Projektpräsen Is werden die	der fokus ler Projek ntation, in Ergebnis	ssiert w tbeark n der d sse sch	verden. Deitung ie Ergek riftlich	Die wird onisse	
3	Lösung Projekt von Auf	managei gaben a	en für ko ment: Gl n die Te	onkrete Problemste iederung in Teilschr am-Mitglieder, Ausv telles Arbeiten und	itte, F wahl g	Formulierung geeigneter Pr	von Zwis äsentatio	schenzi onstech	nniken, j	je nach	
4	-	ements f ungsmod		c ipation n Angabe							
5		f Examir odule Ex Module	aminati	on: nation (Study Examin	natior	n, Special For	m, Passe	ed / No	t Passed	(৮	
6	Require	ements o	on the A	ward of Credit Poin	ts						
7	Gradinរ្ Final M	g odule Ex	aminati	on:							

	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module Vertiefungsbereich (Studienleistung) alternativ zum Seminar. Ergänzungsbereich (benotete Prüfungsleistung, nur nach vorheriger Anmeldung und Genehmigung);
9	Literature wird je nach Thema spezifiziert
10	Comment Verantwortlich: Studiendekan

	Foun	dations	s of Tead	ching and Learning	g of Mathematic	s				
Мо	dule no.			Workload	Self-study	Duration	ı	Freque	ncy	
04-	I-00-0087 8 CP 240 h				180 h	1 Semest	ter	Every 2	. semester	
Lan	guage of	Instruct	ion		Person responsib	le for the	Modu	ıle		
Ger	man				Prof. Dr. phil. nat	. Katja Kri	üger			
1	Course	s of the	Module							
			Course	name	Workload ((CP)	Form Teach		Contact Hours per Week	
	04-00-0	107-ps	Specializ undergr	ed didactics for aduates	0	Proseminar 0		0		
	04-00-0	179-vu	Teaching Mathem	g and Learning of atics	0		Lecture and 4 Exercise		4	
2		of teacl	•	hematics, managen aching in schools wi	•	• •	•	-		
2	Models and cor compet Learnin The stu typical develop	of teach ntent of tences g Outco dents ar math-te be tasks	math-tea mes re able to aching a to suppo		th reasons, methoretical concepts and the students are	ds of long	to des	develop scribe ar ups; to s	nd prepare	

	equivalent
	(participation without certification of prerequisites is possible)
5	Form of Examination
	Final Module Examination:
	 Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Module Examination (Technical Examination, Special Form, Standard)
6	Requirements on the Award of Credit Points
-	Passing the Fachprüfung; passing the Studienleistungen is a prerequisite for taking the
	Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	Passed)
	Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
	• Module Examination (rechnical Examination, Special Form, Weight: 100%, Standard)
8	Usability of the Module
	Mathematics: Teaching degrees
9	Literature
	Bruder, R., Hefendehl-Hebeker, L., Schmidt-Thieme, B. Weigand, HG. (Hrsg.)(2015). Handbuch
	der Mathematikdidaktik. Springer Berlin Heidelberg.
	Bruder, R., Büchter, A. Leuders, T.(2008). Mathematikunterricht entwickeln. Bausteine für
	kompetenzorientiertes Unterrichten. Cornelsen Scriptor.
10	Comment

Мо	dule nam	ne						
	Geor	netry for Tea	chers					
Мо	dule no.	Credit Points	Workload		Self-study	Duration	Frequ	ency
04-	14-00-0091 6 CP 180				120 h	1 Semester	Every	2. semester
Lan	guage of	Instruction	·		Person responsit	ole for the Mo	odule	
Ger	man				Prof. Dr. rer. nat.	Karsten Groß	Se-Braucki	mann
1	Course	s of the Modu	e		•			
	Course	no. Coui	se name		Workload (rm of aching	Contact Hours per

					Week
	04-00-0110-vu	Geometry (for Teaching Degrees)	0	Lecture and Exercise	4
2	Gesetze.	ometrie: Geraden, Dreiecke, Kreis ärische, hyperbolische oder proje		Kegelschnitte, K	Keplersche
3		o mes en kennen und verstehen die elei können diese auf typische Frages	-	Grundbegriffe (und
4	Requirements	for Participation			
5	Form of Examin Final Module Ex • Modul		ation, oral / written Ex	amination, Sta	ndard)
6	Requirements	on the Award of Credit Points			
7	Grading Final Module Ex • Modul Standa	e Examination (Technical Examin	ation, oral / written Ex	amination, Wei	ight: 100%,
8	Usability of the	e Module			
9	Literature				
10	Comment				

Module nam	Module name									
Geor	netry for Teach	ers and DGS	5 onlin	e training						
Module no.	Credit Points	Workload		Self-study		Duration	Frequency			
04-00-0092	7 CP		210 h		150 h	1 Semester	Every 2. semester			

	guage of Instruc		Person responsible for		
	rman		Prof. Dr. rer. nat. Karste	en Große-Brauckm	nann
1	Courses of the	Module			1
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0110-vu	Geometry (for Teaching Degree	es) 0	Lecture and Exercise	4
	04-00-0266-pr	DGS online training	0	Practical / Lab / Internship	0
2	Study Content Siehe Teilmodu	le "Geometrie für das Lehran	nt" und "DGS-Praktikun	n online"	
3	Learning Outco Siehe Teilmodu	mes le "Geometrie für das Lehran	nt" und "DGS-Praktikun	n online"	
4	-	for Participation le "Geometrie für das Lehran	nt" und "DGS-Praktikun	n online"	
	Course Examina	e Examination (Technical Exa			
5	Requirements	on the Award of Credit Point	S		
7	Standa Course Examina	e Examination (Technical Exa rd) ation: -0266-pr] (Study Examination			
	Usability of the	Module			
8	Pflichtmodul				

10	Comment

Мо	dule no.	Credit F	Points	Workload	Self-	study	Duratio	n	Frequ	ency
04-	00-0093		5 CP	150 h		120 h	1 Semes			2. semeste
Language of Instruction					Person responsible for the Module					
Ger	man				Prof.	. Dr. phil. nat	. Katja Kr	üger		
1	Course	Courses of the Module								
	Course	no.	Course	name		Workload ((CP)	Form Teach		Contact Hours per Week
	04-00-0	044-se	Practical mathem	training in schools II atics	for	0		Semina	ar	2
3		g Outco								
3	Die Stu beo anhand verf	dierende bachten fachdid	en , planen aktische	Unterricht, führen o r Kriterien. sentwürfe mit dida						
3	Die Stu beo anhand verf lyse. setz fend au	dierende bachten fachdid fassen U ren sich i seinand	en , planen aktische nterricht mit einer er.	r Kriterien.	ktisch Schw	er und methe erpunktthem	odischer a tieferg	Ana- rei-		
3	Die Stu beo anhand verf lyse. setz fend au arbe in einer	dierende bachten fachdid fassen U ren sich i reseinand eiten mit m online	en , planen aktische nterricht mit einer er. t einer Le -Portfoli	r Kriterien. sentwürfe mit dida n fachdidaktischen ernplattform und do	ktisch Schw	er und methe erpunktthem	odischer a tieferg	Ana- rei-		

	 Module Examination (Technical Examination, Technical Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, Technical Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	Pflicht
9	Literature
	Barzel, B., Holzäpfel, L., Leuders, T., Streit, C. (2011). Scriptor Pra-
	xis - Mathematik: Mathematik unterrichten: Planen, durchführen, reflektie- ren: Buch mit Kopiervorlagen. Cornelsen Verlag Scriptor. Kretschmer, H. Stary, J. (1998). studium kompakt - Pädagogik: Schulpraktikum: Eine Ori-
	entierungshilfe zum Lernen und Lehren. Studienbuch. Cornelsen Lehrbuch
	Meyer, H. (2004). Praxisbuch: Was ist guter Unterricht? Mit didaktischer
	Landkarte. Cornelsen Verlag Scriptor.
10	Comment

Mo	dule nan	ne										
	Math	nematic	s I (Civil	Engineering)								
Mo 04-0 010		Credit I	Points 8 CP			Self-	-study Duration 150 h 1 Semest			Frequency Every 2. semester		
Language of Instruction German						Person responsible for the Module						
1	Courses of the Module											
	Course no. Course			name			Workload ((CP)	Form Teacł		Contact Hours per Week	
	04-00-0	120-vu	Calculus	I (civil engineerir	ıg)		0		Lectur Exercis		6	
2	Study Content Real and complex numbers, vectors, scalar and vector product, complex numbers, systems of linear equations, linear maps, matrices, determinants, eigenvalues, orthogonal matrices,											

	sequences and series, differential and integral calculus in one variable.
3	Learning Outcomes Nachdem Studierende das Modul besucht haben, können sie die grundlegenden Begriffsbildungen und Resultate der linearen Algebra und der Analysis einer Veränderlicher wiedergeben, ihre inhaltlich-logischen Beziehungen und ihre geometrische Bedeutung erklären und ihre Rolle in den Naturwissenschaften beschreiben. Sie können die wichtigsten zugehörigen rechnerischen Methoden anwenden und in ihrer Bedeutsamkeit und Zuverlässigkeit beurteilen. Sie können sich im späteren Studium und Beruf die benötigten mathematischen Kenntnisse selbst erarbeiten.
4	Requirements for Participation
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Written Exam, Duration 90 min, Standard)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination: • Module Examination (Technical Examination, Written Exam, Weight: 100%, Standard) Usability of the Module
9	Literature v. Finkenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch Mathematik für Ingenieure Band I, Analysis und Lineare Algebra, 4. Aufl., Teubner, 2006.
10	Comment

Module nam	Module name										
Calculus I (civil engineering)											
Module no. 04-00- 0104/s	Credit Points 8 CP	Workload	240 h	Self-study 15		Duration 1 Semester	Frequency Every 2. semester				
Language of		Person responsible for the Module									

Ger	man										
1	Courses of the	Module									
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-00-0120-vu	Calculus I (civil engineering)	0	Lecture and Exercise	6						
2	Study Content Real and complex numbers, vectors, scalar and vector product, sequences and series, differential and integral calculus in one variable, fundamental theorem of calculus, Taylor series, numerical integration.										
3	Learning Outcomes Nachdem Studierende das Modul besucht haben, können sie die grundlegenden Begriffsbildungen und Resultate der Analysis einer Veränderlicher wiedergeben, ihre inhaltlich- logischen Beziehungen erklären und ihre Rolle in den Naturwissenschaften beschreiben. Sie können die wichtigsten zugehörigen rechnerischen Methoden anwenden und in ihrer Bedeutsamkeit und Zuverlässigkeit beurteilen. Sie können sich im späteren Studium und Beruf die benötigten mathematischen Kenntnisse selbst erarbeiten.										
4	Requirements f	for Participation									
5	Form of Examir Final Module Ex • Module		nation, oral / written Exa	mination, Stand	lard)						
6	Requirements o	on the Award of Credit Poin	ts								
7	Grading Final Module Examination: Module Examination (Study Examination, oral / written Examination, Weight: 100%, Standard)										
8	Usability of the Pflicht für B.Sc.I Prüfungen	BIGeo: zusammen mit Mathe	ematik II in zwei getrenn	ten							
9		Lehn, Schellhaas, Wegmann: neare Algebra, 4. Aufl., Teubi		ik für Ingenieure	Band I,						
10	Comment										

Мо	dule nan	ne									
		nematic	s II (Civi	l Engineering)							
_	dule no.	Credit F	Points	Workload	Self-study Duration			n	Freque	ency	
04-(010			8 CP	240 h		150 h	1 Semester		Every 2	. semester	
Lan	guage of	Instruct	ion	L	Pers	on responsib	le for the	e Modu	ule		
Ger	man										
1	Course	s of the	Module								
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0	074-vu	Calculus	II (civil engineering)		0		Lectur Exercis		6	
3	Nachde Begriffs mehrer geomet	Learning Outcomes Nachdem Studierende das Modul besucht haben, können sie die grundlegenden Begriffsbildungen und Resultate der Theorie der Taylor- und Fourier-Reihen und der Analysis mehrerer Veränderlicher wiedergeben, ihre inhaltlich-logischen Beziehungen und ihre geometrische Bedeutung erklären. Sie können Begriffe der Analysis mehrerer Veränderlicher									
	wiedererkennen und ihre Rolle in den Naturwissenschaften beschreiben. Sie können die wichtigsten zugehörigen rechnerischen Methoden anwenden und in ihrer Bedeutsamkeit und Zuverlässigkeit beurteilen. Sie können sich im späteren Studium und Beruf die benötigten mathematischen Kenntnisse selbst erarbeiten.										
4	Requirements for Participation Recommended: Mathematik I (04-00-0104/f)										
	Recom	mended	Mather	natik i (04-00-0104/	1)						
5	Form o	f Examir odule E>	nation camination			ation, Writter	n Exam, D	ouratio	n 90 mir	n, Standard	

7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, Written Exam, Weight: 100%, Standard)
8	Usability of the Module
9	Literature v. Finkenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch Mathematik für Ingenieure Band I, Analysis und Lineare Algebra, 4. Aufl., Teubner, 2006.
10	Comment

Mo	dule nan	-		in a crime)							
04-(Module no		(civil engineering) t Points Workload 8 8 CP 240 h			study Duration 150 h 1 Semest				ency 2. semester	
	Language of Instruction German						on responsib	le for the	e Modu	le	
1	L Courses of the Course no.		Module Course	name			Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-00-0074-vu		Calculus	culus II (civil engineering)			0			e and se	6
2	Linear a orthogo calculu variable	onal mat s of func es: integ	tions of ration ov	of linear equa adratic forms several variab ver 2 and 3-din al theorems.	and coles: In	onic s tegra	ections; diffe	erential ons of se	veral	ues,	
3	Learning Outcomes Nachdem Studierende das Modul besucht haben, können sie die grundlegenden Begriffsbildungen und Resultate der Vektorrechnung und Linearen Algebra wiedergeben, ihre inhaltlich-logischen Beziehungen und ihre geometrische Bedeutung erklären. Sie können Begriffe der Linearen Algebra in der Analysis mehrerer Veränderlicher wiedererkennen und ihre Rolle in den Naturwissenschaften beschreiben. Sie können die wichtigsten zugehörigen										

rechnerischen Methoden anwenden und in ihrer Bedeutsamkeit und Zuverlässigkeit beurteilen. Sie können sich im späteren Studium und Beruf die benötigten mathematischen Kenntnisse selbst erarbeiten.
seibst erarbeiten.
Requirements for Participation
Mathematik I
Form of Examination
Final Module Examination:
Module Examination (Study Examination, oral / written Examination, Standard)
Requirements on the Award of Credit Points
Grading Final Module Examination:
 Module Examination (Study Examination, oral / written Examination, Weight: 100%, Standard)
Usability of the Module
Pflicht für B.Sc.BauGeo: zusammen mit Mathematik I in zwei getrennten Prüfungen
Literature
v. Finkenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch Mathematik für Ingenieure Band I, Analysis und Lineare Algebra, 4. Aufl., Teubner, 2006.
Comment

Mo	dule nam	ne										
	Math	nematics III	Civil E	ngineeri	ng)							
Mo 04-0 010		Credit Point 8	s Wo	orkload	240 h	Self-s	-	150 h	Duratior 1 Semes	-	Frequei Every 2	ncy . semester
	Language of Instruction German					Person responsible for the Module						
1	Course	s of the Mod	ıle			,						
	Course	se no. Course		name			Workload (C		CP) Form Teacl		•••	Contact Hours per

					Week				
	04-00-0121-vu	Calculus III (civil engineering)	0	Lecture and Exercise	6				
2	Study Content 1) Differential e	equations:							
	b) Second order variable coeffic	dinary differential equations - e r ordinary differential equations ients, systems of linear different ential equations - classification,	- linear differential eq tial equations;	uations with co					
	2) Calculus of variations;								
	3) Probability theory - conditional probabilities, random variables and distribution functions, mean and variance, central limit theorem;								
	4) Statistics:								
	 a) descriptive statistics; b) estimation techniques and confidence intervals - unbiasedness and consistency, maximum likelihood estimate; c) statistical tests - tests assuming Gaussian distribution, chi^2 test of goodness of fit, analysis of variance; 								
3	Learning OutcomesIm Rahmen des für ihren Studiengang Erforderlichen sollen die Studierenden über Vertrautheit mit den einfachsten Typen von Differentialgleichungen und den Anfangsgründen der Stochastik verfügen. Die Studierenden besitzen die Fähigkeit, die wichtigsten rechnerischen Methoden in ihrer Bedeutsamkeit beurteilen und auf ingenieurtechnische Fragen, insbesondere im späteren Studium und Beruf anwenden zu können. Sie besitzen Grundvoraussetzungen, sich die benötigten mathematischen Kenntnisse selbst anzueignen.								
4	-	for Participation : Mathematik I and II (04-00-010	04/f/ 04-00-0105/f)						
5	Form of Examir Final Module Ex Module		nation, Written Exam,	Duration 90 mi	in, Standard)				
6	Requirements o	on the Award of Credit Points							
7	Grading Final Module Ex	kamination: e Examination (Technical Exami	nation, Written Exam, '	Weight: 100%,	Standard)				

8	Usability of the Module
9	Literature wird zu Beginn der VL bekannt gegeben.
10	Comment
10	Comment

Мо	dule nam	ne								
	Calcu	ılus III (civil eng	(ineering)						
04-	dule no. 00- 06/s	Credit F	Points Workload S		Self-	study 90 h	Duration 1 Semester		Frequency Every 2. semester	
	Language of Instruction German					on responsib	le for the	e Modu	ule	
1	Course	s of the I	Module							
	Course no. 04-00-0121-vu		Course	name			Form Teach	-	Contact Hours per Week	
			Calculus	III (civil engineering)	i) 0 Lecture an Exercise				6	

3	Learning Outcomes
	Im Rahmen des für ihren Studiengang Erforderlichen sollen die Studierenden
	über Vertrautheit mit den einfachsten Typen von Differentialgleichungen
	und den Anfangsgründen der Stochastik verfügen. Die Studierenden
	besitzen die Fähigkeit, die wichtigsten rechnerischen Methoden in ihrer Bedeutsamkeit
	beurteilen und auf ingenieurtechnische Fragen, insbesondere im
	späteren Studium und Beruf anwenden zu können. Sie besitzen Grundvoraussetzungen,
	sich die benötigten mathematischen Kenntnisse selbst anzueignen.
4	Requirements for Participation
	gute Kenntnisse in Mathe I und II
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Study Examination, Study Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc.BI/UI, B.Sc.MaWi: Pflichtveranstaltung, WIBI benötigen nur den Statistik-Teil
9	Literature
	wird zu Beginn der VL bekannt gegeben.
10	Comment

Module nam	Module name													
Math	Mathematics I (Electrical Engineering)													
Module no.	Credit Points	Workload		Self-study	Duration	Frequency								
04-00-0108	9 CP	27	70 h	180 h	1 Semester	Every 2. semester								
Language of	Instruction			Person responsible for the Module										
German				Apl. Prof. Dr. rer.	nat. Steffen Roo	h								

			Workload (CP)	Form of Teaching	Contact Hours per Week	
	04-00-0126-vu	Mathematics I (Electical Engineering)	0	Lecture and Exercise	6	
2		l complex numbers, real funk s in one variable, vector spac s				
3	 den elementa den elementa Die Studierend linearer Algeb analytischer G 	en sind vertraut mit ren Methoden der mathema ren Methoden des logischen en beherrschen die Grundzüg ora	Schließens ge von			
4	Requirements keine	for Participation				
5	Usually the exa number of pote (30 min). The d		en test (90 min), except e, the exam can be take e exam is taken and com	when there are on the start of a	only a small an oral exan	
6	Requirements	on the Award of Credit Point	ts			
7	Grading Final Module E Modul Standa	e Examination (Technical Exa	amination, oral / written	Examination, W	eight: 100%	

10	Comment
9	Literature Von Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch für Ingenieure I, Teubner, Burg, Haf, Wille: Höhere Mathematik für Ingenieure I, II, Teubner, Meyberg, Vachenauer, Höhere Mathematik 1, Springer
	Für B.Sc.ETiT, B.Ed.ETiT, B.Sc.WIETiT, B. Sc. Mec, B. Sc. CE, B. Sc. IST, B. Sc. MedTech

Мо	dule nam	-								
Mo			-	ctrical Engineering Workload		study	Duratior		Froque	
	Iodule no.Credit PointsWorkload4-00-01099 CP270					-	1 Semes		Freque Everv 2	2. semester
	guage of	Instruct				on responsib				
	man					Prof. Dr. rer.				
1	Course	s of the	Module							
	Course	no.	Course	name		Workload (0	CP)	Form Teach	-	Contact Hours per Week
	04-00-0	079-vu	Mathem Engineer	atics II (Electrical ring)	0			Lecture and 6 Exercise		6
	Taylor a	and Four	ier serie	ues, quadratic forms s, differentiala calcu ath integrals, integr	ilus in	R^n, extrem			15,	
3	Learnin	g Outco	mes							
	•	Die Stu	dierende	n besitzen ein verti	eftes \	Verständnis r	nathema	tischer	r Prinzip	bien
	 Die Studierenden beherrschen die Grundzüge der Analysis von Funktionen mehrerer Veränderlichen 									
	•			n können die Analy obleme der Ingenie					nderlicl	hen unter
4	Require	ements	for Partic	cipation						

	Recommended: Mathematik I (für ET)
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam (30 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc.ETIT, B.Ed.ETIT, B.Sc.WIETIT, B. Sc. Mec, B. Sc. CE, B. Sc. IST, B. Sc. MedTech
9	Literature Von Finckenstein/Lehn/Schellhaas/Wegmann: Arbeitsbuch Mathematik für Ingenieure. Band I, Teubner Verlag, Burg, Haf, Wille: Höhere Mathematik für Ingenieure I, II, Teubner Verlag, Meyberg, Vachenauer: Höhere Mathematik 1, Springer Verlang
10	Comment

Мос	Module name												
Mathematics III (Electrical Engineering)													
Module no. Credit Points Workload					Self-study Duration Frequenc				су				
04-0	4-00-0111 9 CP 270 h		270 h	180 h 1 Semester Every 2. sen			semester						
Lang	guage of	Instruct	ion			Perso	on responsi	ble for the	Modu	ıle			
Geri	man					Apl. I	Prof. Dr. rer	nat. Steff	en Roo	ch			
1	Courses of the Module												
Course no. Course name Workload (CP) Form of Co							Contact						

				-								
				Teaching	Hours per Week							
	04-00-0127-vu	Mathematics III (Electrical Engineering)	0	Lecture and Exercise	6							
2	equations: linea of solutions, ele coefficients, Lap differentiation,	Study Content integral calculus: surface integrals, integral theorems; ordinary differential equations: linear and non-linear differential equations, existence and uniqueness of solutions, elementary techniques, linear systems with constant coefficients, Laplace transform; Complex Analysis: complex functions, complex differentiation, Cauchy's integral formula, power series and Laurent series, residues, residue theorem										
3	Die Studierende - zur Modellieru - zur Analyse vo Die Studierende - grundlegende - explizite Lösur	Learning Outcomes Die Studierenden erwerben die mathematischen Fähigkeiten - zur Modellierung von ingenieurwissenschaftlichen Sachverhalten - zur Analyse von ingenieurwissenschaftlichen Sachverhalten Die Studierenden kennen - grundlegende Lösungseigenschaften - explizite Lösungsmethoden für gewöhnliche Differentialgleichungen Die Studierenden beherrschen die Grundzüge der komplexen Funktionentheorie.										
4	-	or Participation Mathematik I und Mathematil	k ll (für ET)									
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam (30 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 											
6	Requirements o	on the Award of Credit Points										
7	Grading Final Module Ex • Module Standar	e Examination (Technical Exami	ination, oral / written Ex	amination, We	eight: 100%,							

8	Usability of the Module B.Sc.ETIT, B.Ed.ETIT, B.Sc.WIETIT, B. C. MedTech, B.Sc.MEC, B.Sc.CE, B.Sc.IST
9	Literature Von Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch für Ingenieure II, Teubner, Burg, Haf, Wille: Höhere Mathematik für Ingenieure III, IV, Teubner Freitag, Busam: Funktionentheorie 1, Springer
10	Comment

Mo	dule nan	ne								
				stical Methods					1	
	dule no.	Credit F	oints	Workload	Self-	study	Duratio	-	Freque	-
04-0	00-0112		9 CP	270 h		180 h	1 Semes	ter	Every 2	2. semester
	guage of man	Instruct	ion			on responsib . Dr. rer. nat.			ule	
		<i></i>			PIOI	. Dr. rer. nat.	Steran U	IDHCH		
1	1 Courses of the N Course no.		Course	name		Workload (CP)	Form Teacł	-	Contact Hours per Week
	04-00-0	-00-0081-vu Numerical and Statistical Methods 0					Lecture and 6 Exercise		6	
2	system method Statistic multiva	ical Anal ^ı s of nonl ds for eig cs: basic ıriate dis	inear eq envalue concept tributior	ar equations, interp uations, initial value problems s of statistics and pr ns, methods of estin random variables, n	e prot obab natior	ility theory, r , confidence	Es, nume egressior	rical n,		
3	Learning Outcomes Fähigkeit für grundlegende Aufgabenstellungen geeignete numerische Verfahren auszuwählen und anzuwenden. Fähigkeit statistische Auswertungen vorzunehmen, grundlegende Schätzverfahren und Testverfahren durchzuführen.									
4	Requirements for Participation Mathematik 1 und Mathematik 2									

5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	Für B.Sc.ETIT, B.Sc.MEC, B.Sc.CE, B.Sc.Inf, M.Ed.Math, B.Sc.IST (PO
	2007): Pflicht Für B.Sc.EPE, B.Sc.IST (bis PO 2006), B.Sc.iKT: Pflicht
	zusammen mit Mathematik 3 als Mathematik B
9	Literature
	Von Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch für Ingenieure
	II, Teubner Verlag Stuttgart;
10	Comment

Мос	dule nam	ne								
	Math	nematio	s I (Mec	hanical and Proce	ess Er	ngineering)				
Module no. Credit Points Workload						study	Duratio	n	Freque	ency
04-0	00-0114		8 CP	240 h		150 h	1 Semes	ster	Every 2	2. semester
Language of InstructionPerson responsible for the ModuleGermanProf. Dr. rer. nat. Ulrich Reif										
1	Courses of the Module									
	Course no. Course name				Workload ((CP)	Form Teacł	•	Contact Hours per Week	
	04-00-0	124-vu	Mathem Engineer	atics for Mechanical ring I		0		Lectur Exercis		6
2	Study C	Content								
	Vectors, complex numbers, linear systems of equations, matrices, linear maps, eigenvalues and -vectors, sequences, series,									

	function limits, continuity, differentiation, integration
3	Learning Outcomes
	Nach erfolgreichem Abschluss des Moduls können die Studierenden.
	 elementare Methoden der mathematischen Begriffsbildung und des logischen Schließens anwenden,
	 die grundlegenden Begriffsbildungen und Resultate der linearen Algebra und der analytischen Geometrie wiedergeben und anwenden,
	• die grundlegenden Begriffsbildungen und Resultate der Analysis einer Veränderlicher wiedergeben und anwenden,
	ihre inhaltlich-logischen Beziehungen erklären,
	 die wichtigsten zugehörigen rechnerischen Methoden anwenden und in ihrer Bedeutsamkeit und Zuverlässigkeit beurteilen,
	 sich im späteren Studium und Beruf benötigte weitergehende mathematische Kenntnisse selbst erarbeiten.
4	Requirements for Participation keine
5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflicht
9	Literature
	 v. Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch Mathematik f ür Ingenieure Band I, Analysis und Lineare Algebra, 4. Aufl., Teubner, 2006.

	•	Höllig, Hörner: Aufgaben und Lösungen zur Höheren Mathematik 1, 2. Aufl., Springer, 2019.
	•	Papula: Mathematik für Ingenieure und Naturwissenschaftler Band 1 und 2, 14. Aufl., Springer Vieweg, 2014.
10	Comm	ent

	Iviati	ematic	s II (Me	chanical ar	nd Proc	ess E	ngineering)			1	
Module no. Credit Points Worklo				Workload		Self-	study	Duratio	n	Freque	ency
04-00-0115 8 CP 24				240 h		150 h	1 Semes	ter	Every 2	2. semeste	
Language of Instruction German							on responsib . Dr. rer. nat.			ule	
1	Course	s of the	Module								
	Course	Course no. Course nam					Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-00-0	076-vu	Mathem Engineer	atics for Mec ring II	chanical		0		Lecture and 6 Exercise		6
	values	-		•			veral variable in several var	-			
		with and	without	constraints	, integra	ation		iables, lii	ne		
3	integra	with and s of vect g Outco folgreic die gruu Reihen die gruu Veränd	without tor fields mes hem Abs ndlegend wiederge ndlegend erlicher v	constraints , flow integr chluss des N len Begriffsk eben und ar	, integra rals, vec Moduls l oildunge nwender oildunge n und ar	ation tor ca conne en une n, en une nwen	in several var alculus, integr en die Studier d Resultate d d Resultate d den,	ral theore enden: er Theori	ne ems e der T	·	ınd Fouriei

	 sich im späteren Studium und Beruf benötigte weitergehende mathematische Kenntnisse selbst erarbeiten.
4	Requirements for Participation Mathematik 1
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflicht
9	 Literature v. Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch Mathematik für Ingenieure Band I, Analysis und Lineare Algebra, 4. Aufl., Teubner, 2006. Höllig, Hörner: Aufgaben und Lösungen zur Höheren Mathematik 2, 2. Aufl., Springer, 2019. Papula: Mathematik für Ingenieure und Naturwissenschaftler Band 1 und 2, 14. Aufl., Springer Vieweg, 2014.
10	Comment

Module name								
Math	Mathematics III (Mechanical and Process Engineering)							
Module no.	Credit Points	Workload	Self-study		Duration	Frequency		
04-00-0116	4 CP	120	h	60 h	1 Semester	Every 2. semester		
Language of	Person resp	onsib	le for the Mod	ule				

Gerr	nan		Prof. Dr. rer. nat. Jens La	ing	
1	Courses of the	Module	•		
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0125-vu	Mathematics for Mechanical Engineering III	0	Lecture and Exercise	4
2	Differenzialgleid Anfangswertpro Ordnung, Stabil nichtlineare Zw Differenzialgleid	ifferenzialgleichungen: Grun chungen und spezielle Typer obleme, lineare Systeme ers ität von Differenzialgleichur eipunkt-Randwertprobleme chungen: Grundbegriffe für chungen erster Ordnung, pa chungen	n zweiter Ordnung, Lösun ter Ordnung, lineare Diffe ngen, Laplace-Transforma r, Sturm-Liouville-Problem partielle Differenzialgleich	gstheorie für erenzialgleichun tion, lineare und ne; Partielle nungen, partielle	gen n-ter d
3	 die grun Differen ihre inh die wich anwend die Lösn sich im 	hem Abschluss des Moduls I ndlegenden Lösungseigensc nzialgleichungen wiedergeb naltlich-logischen Beziehungen htigsten Lösungsmethoden f	haften gewöhnlicher und en, en erklären, für analytisch lösbare Fäll eutsamkeit und Zuverlässi	der einfachsten e auswählen un gkeit beurteilen	d
4	Requirements f keine	or Participation			
5	Form of Examir Final Module Ex • Module		amination, oral / written	Examination, St	andard)
6	Requirements o	on the Award of Credit Poin	its		
7	Grading Final Module Ex	amination:			

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflicht
9	 Literature v. Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch Mathematik für Ingenieure Band II, 3. Aufl., Teubner, 2006. Papula: Mathematik für Ingenieure und Naturwissenschaftler Band 2, 14. Aufl., Springer Vieweg, 2015.
10	Comment

Мо	dule nan	ne								
	Num	erical A	nalysis	(Mechanical and	Proce	ess Engineer	ing)			
Mo	dule no.	Credit I	Points	Workload	Self-	study	Duration	า	Freque	ncy
04-00-0117 4 CP 12				120 h		60 h	1 Semes	ter	Every 2	. semester
Lan	guage of	Instruct	tion		Pers	on responsib	le for the	Modu	ule	
Ger	man				Prof	. Dr. rer. nat.	Jens Lang	5		
1	Course	s of the	Module							
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	077-vu	Numeric	al Analysis		0		Lecture and Exercise		4
2	Study C	Content								
	differer	ntiation	and integ	quation systems, lea gration, initial value value problems.			-	•	-	•
3	Learning Outcomes Fähigkeit für grundlegende Aufgabenstellungen geeignete numerische Verfahren auszuwählen und anzuwenden.									
4	Require	ements	for Partio	ipation						

	Mathematik I-II
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc.MPE, B.Sc.AngMech: Pflicht
9	Literature
	Von Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch für Ingenieure II, Teubner Verlag Stuttgart
10	Comment

Mod	dule nam	ne								
	Math	nematic	s I (for C	Computer Science)					
Мос	dule no.	Credit F	Points	Workload	Self-study		Duratior	n	Frequer	ю
04-0	0-0118		9 CP	270 h		180 h	1 Semes	ter	Every 2.	semester
Lang	guage of	Instruct	ion		Pers	on responsib	le for the	Modu	ule	
Gerr	man				Prof	Dr. phil. nat	Ulrich Ko	bhlenb	ach	
1	Course	s of the	Module							
	Course no. Course		Course	name		Workload (CP)		Form Teacł	•.	Contact Hours per Week
	04-00-0	128-vu	Mathem	atics I (Computer Scie	ence)	0		Lectur Exercis		6
2	Study C	Content								
	•	Basics:	relations	, functions, groups,	rings	, fields, comp	lex numb	oers, m	netrics	

	 Linear algebra: vector spaces, basis, scalar products, linear maps, systems of linear equations, change of coordinates, determinants, eigenvalues, eigenvectors Analysis over R: sequences, convergence, asymptotics, series, compactness, continuity
3	Learning Outcomes Nach Abschluss des Moduls können die Studierenden:
	- mit abstrakten Begriffen präzise umgehen, Beweise nachvollziehen, Beweisideen erläutern und auch selbstständig Beweise führen,
	- die axiomatisch-deduktive Vorgehensweise der Mathematik verstehen und anwenden,
	- die vermittelten Kenntnisse und Begriffe aus zentralen Gebieten der Mathematikgrundausbildung beherrschen, so dass sie diese für die verschiedenen Anwendungen in der Informatik nutzen können.
	Die Studierenden sollen
	- mit mathematischer Methodik und Fachkultur vertraut sein.
	- in der Lage sein, aufbauend auf das vermittelte Grundwissen Mathematik, weitere mathematische Inhalte selbstständig zu erarbeiten.
4	Requirements for Participation keine
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflicht
9	Literature Skript der Veranstaltung

10	Comment

Mo	dule no.		-	Computer Scie		elf-study	Duration	า	Freque	encv
-	00-0119		9 CP	270			1 Semes		-	2. semeste
Lar	guage of	Instruct	ion	I	Pe	erson responsib	le for the	e Modu	ule	
	rman					of. Dr. phil. nat.				
1	Course	s of the	Module		·					
	Course	no.	Course	name		Workload (C	CP)	Form Teacł	-	Contact Hours per Week
	04-00-0	087-vu	Mathem Science)	atics II (Computer		0		Lecture Exercis		6
	•	Taylor T Analysis	Theorem s over Rr	power series, sta , extremal values n: Continuity, par ential equations:	, Four ial an	rier series nd total differen	tiability,	extrem	nal value	es, curves
	•	Taylor T Analysis Ordinar	Theorem s over Rr Ty differe	, extremal values	, Four ial an ystem	rier series nd total differen ns of linear ODE	tiability, S, Picard	extrem -Lindel	nal value löf Theo	es, curves
3	Learnin	Taylor T Analysis Ordinar Univers	Theorem s over Rr ry differe al algebr mes	, extremal values n: Continuity, par ential equations: :	, Four ial an ystem ubalg	rier series nd total differen ns of linear ODE gebras, homomo	tiability, S, Picard	extrem -Lindel	nal value löf Theo	es, curves
3	Learnin Nach A - mit ab	Taylor T Analysis Ordinar Univers ng Outco bschluss	Theorem s over Rr y differe al algebr mes des Moo n Begriffe	, extremal values n: Continuity, par ential equations: s ra: algebras und s	, Four ial an ystem ubalg tudiei	rier series nd total differen ns of linear ODE gebras, homomo	tiability, s, Picard orphisms,	extrem -Lindel , quotio	nal value löf Theo ents	es, curves prem
3	Learnin Nach A - mit at auch se	Taylor T Analysis Ordinar Univers og Outco bschluss ostrakter elbststän	Theorem s over Rr y differe al algebr mes des Moo h Begriffe dig Bewe	, extremal values n: Continuity, par ential equations: : ra: algebras und s duls können die S en präzise umgeh	, Four ial an ystem ubalg tudier en, Be	rier series nd total differen ns of linear ODE gebras, homomo renden: eweise nachvoll	tiability, s, Picard orphisms, ziehen, B	extrem -Lindel , quotio	nal value löf Theo ents ideen er	es, curves prem

	Die Studierenden sollen
	- mit mathematischer Methodik und Fachkultur vertraut sein.
	- in der Lage sein, aufbauend auf das vermittelte Grundwissen Mathematik, weitere mathematische Inhalte selbstständig zu erarbeiten.
4	Requirements for Participation Mathematik I
5	Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam (30 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflicht
9	Literature Skript der Veranstaltung
10	Comment

			•	-		I: Automata an			i –		
	Iodule no.Credit PointsWorkload4-00-01205 CP150				50 h	elf-study	Duration 1 Semes		Freque	e ncy 2. semester	
		Instruct		1.						. semester	
	i guage of rman	mstruct	.1011			Person responsible for the Module Prof. Dr. rer. nat. Martin Otto					
1		Courses of the Module									
_	Course		Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week	
	04-00-0	091-vu	Automat Decidabi	ta, Formal Langu ility	ages and	d 0		Lecture Exercis		3	
	properties and automata constructions, Kleene Theorem, Myhill-Nerode Theorem, pumpin lemma; grammars and the Chomsky hierrachy, context-free languages, pumping lemma, CYK algor models of computation: PDA and Turing machines; decidability and recursive enumerabilit the Chomsky hierarchy								uma mila ~		
	lemma; gramm models the Cho	; ars and t of comp omsky hi	the Chon outation: erarchy	nsky hierrachy,	contex	t-free languages	s, pumpir	ng lemr	ma, CYK	algorithm	
3	lemma; gramm models the Cho Learnin Die Stu Umfeld Automa zu inter Sie verf	; of comp omsky hi o g Outco dierende von form aten als pretiere ügen üb n der Ch	the Chon outation: erarchy mes en lerner malen Sp Beispiel e en und zu er die no	nsky hierrachy, PDA and Turin elementare Te prachen und Au eines fundamer analysieren. otwendigen Gru	contex og mach echnike itomate ntalen E	t-free languages	s, pumpir y and rec n der disl nzuwend dells ope atiken un	ng lemr cursive kreten len; sie rationa	ma, CYK enumer Mather e lernen, al und se	algorithm rability in natik im endliche emantisch rachen im	
	lemma; gramm models the Cho Learnin Die Stu Umfeld Automa zu inter Sie verf Rahme analysie	; of componsky hi o g Outco dierende von forr aten als f rpretiere ügen üb n der Ch eren.	the Chon outation: erarchy mes en lerner malen Sp Beispiel e en und zu er die no	nsky hierrachy, PDA and Turin elementare Te prachen und Au eines fundamer analysieren. otwendigen Gru lierarchie und z	contex og mach echnike itomate ntalen E	kt-free languages hines; decidabilit en und Methode en kennen und a Berechnungsmo ntnisse, Gramm	s, pumpir y and rec n der disl nzuwend dells ope atiken un	ng lemr cursive kreten len; sie rationa	ma, CYK enumer Mather e lernen, al und se	algorithm, rability in natik im endliche emantisch rachen im	
4	lemma; gramm, models the Cho Learnin Die Stu Umfeld Automa zu inter Sie verf Rahmer analysie Require keine	; of componsky hi og Outco dierende von formaten als rpretiere fügen üb n der Ch eren. ements f	the Chon butation: erarchy mes en lerner malen Sp Beispiel e en und zu er die nc omsky-H	nsky hierrachy, PDA and Turin n elementare Te prachen und Au eines fundamer analysieren. otwendigen Gru lierarchie und z	contex og mach echnike itomate ntalen E	kt-free languages hines; decidabilit en und Methode en kennen und a Berechnungsmo ntnisse, Gramm	s, pumpir y and rec n der disl nzuwend dells ope atiken un	ng lemr cursive kreten len; sie rationa	ma, CYK enumer Mather e lernen, al und se	algorithm rability in natik im endliche emantisch rachen im	
3 4 5	lemma; gramm, models the Cho Learnin Die Stu Umfeld Automa zu inter Sie verf Rahmer analysie Require keine	; of componsky hi og Outco dierende von fornaten als rpretiere ügen üb n der Ch eren. ements f f Examir	the Chon butation: erarchy mes en lerner malen Sp Beispiel e en und zu er die nc omsky-H for Partic	nsky hierrachy, PDA and Turin n elementare Te prachen und Au eines fundamen a analysieren. otwendigen Gru lierarchie und z cipation	contex ag mach echnike atomate ntalen E undkeni ugehör	kt-free languages hines; decidabilit en und Methode en kennen und a Berechnungsmo ntnisse, Gramm	s, pumpir y and rec n der disl nzuwend dells ope atiken un gsmodelle	kreten len; sie rationa d form e einzu	ma, CYK enumen Mather e lernen, al und se nalen Sp iordnen	algorithm rability in natik im endliche emantisch rachen im und zu	

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflichtveranstaltung in Informatik-Studiengängen
9	Literature Schöning: Theoretische Informatikkurz gefasst Hopcroft, Motwani, Ullman: Einführung in die Automatentheorie, formale Sprachen und Komplexitätstheorie Wegener: Theoretische Informatikeine algorithmenorientierte Einführung Skript (elektronisch unter <u>www.mathematik.tu-darmstadt.de#47;~otto</u>)
10	Comment

	Form	al Princ	ciples of	Computer Scienc	e II: L	ogic for Coı	mputer S	Scienc	e	
Мо	dule no.	Credit F	Points	Workload	Self-s	study	Duratio	n	Freque	ncy
04-(00-0121 5 CP 150 h		150 h		105 h	1 Semes	ter	Every 2	. semester	
Lan	guage of	Instruct	ion		Perso	on responsib	le for the	e Modu	ule	
Ger	man				Prof.	Dr. rer. nat.	Martin O	tto		
1	Course	s of the	Module							
	Course	Course no.		name		Workload (CP)		Teaching F		Contact Hours per Week
	04-00-0	090-vu	Proposit Logic	tional Logic and Predicat		ate 0		Lectur Exercis		3
2	function comple syntax a structur Herbran calculus undecid	and sem nal comp te proof and sem res and a nd theor s, Gödel' dability c	oleteness calculi: antics of assignme rem, com s Comple of first-or	propositional logic, s and normal forms, resolution and a sec first-order logic, ents, normal forms, pactness, complete eteness Theorem; der logic; expressiveness and	, comp quent Skoler e proo	calculus; nization, f calculi: (gro	ound) reso	olution	i and a se	equent

-	
3	Learning Outcomes Die Studierenden werden mit Inhalten und Methoden der mathematischen Logik und ihrer Rolle
	in der Informatik vertraut gemacht. Sie lernen die grundlegenden Begriffe und Resultate der
	Logik, insbesondere der Logik erster Stufe, kennen und anzuwenden. Sie beherrschen die
	grundsätzlichen mathematischen Methoden in der Behandlung von Syntax, Semantik und
	formalen Beweisen, sowie die Diskussion einfacher modelltheoretischer und algorithmischer
	Aspekte der behandelten logischen Systeme
	Aspekte der benändelten lögisenen systeme
4	Requirements for Participation
	mathematische Allgemeinbildung und Formale Grundlagen I
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	• Would Examination (reclinical Examination, orary written Examination, Standard)
6	Requirements on the Award of Credit Points
_	
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
	Standard)
8	Usability of the Module
	Pflichtveranstaltung in Informatikstudiengängen
9	Literature
	Burris: Logic for Mathematics and Computer Science
	Schöning: Logik für Informatiker
	Boolos, Burgess, Jeffrey: Computability and Logic
	Skript (2 Teile, elektronisch unter www.mathematik.tu-darmstadt.de#47;~otto)
10	Comment

Module name									
Proje	ect in Mathema	tics							
Module no.	Credit Points	Workload	Self-study 154.285720825	Duration	Frequency				

04-0	0-0123		6 CP	180 h		2 h	1 Semes	ter	Every	semester	
Lang	uage of	Instruct	tion		Person responsible for the Module						
Gern	nan and	English			Studiendekan*in des Fachbereichs 04						
1	Courses	s of the	Module								
	Course no.		urse no. Course name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-00	094-pj	Project fo Engineeri	r Computational ng		0		Projec	t	0	
	04-10-03	358-se	Seminar iı Bachelor	n Mathematics (num	ı) <i>,</i>	0		Semin	ar	2	
	04-10-03	359-se	Seminar iı Bachelor	n Mathematics (num	ı) <i>,</i>	0		Semin	ar	2	
	04-10-03	360-se	Seminar iı Bachelor	n Mathematics (opt)	,	0		Semin	ar	2	
	04-10-03	361-se	Seminar iı Bachelor	n Mathematics (opt)	,	0		Semin	ar	2	
	04-10-03	362-se	Seminar iı Bachelor	n Mathematics (sto),	,	0		Semina	ar	2	
	04-10-03	363-se	Seminar iı Bachelor	n Mathematics (sto),	,	0		Semin	ar	2	
2	Study C interdis		y project v	vith changing topic	cs						
3	Lösungs Projekt von Auf	manage fgaben a	ien für kor ment: Glie in die Teai	nkrete Problemste ederung in Teilschr m-Mitglieder, Ausv elles Arbeiten und e	itte, wahl	Formulierung geeigneter Pr	von Zwis äsentatio	chenz onstech	nniken,	je nach	
4	•		for Partici ule und W	pation /ahlveranstaltunge	n au	s der Mathem	iatik				
5	Form of Examination Final Module Examination: • Module Examination (Study Examination, Study Examination, Passed / Not Passed)										
6	Require	ements	on the Aw	ard of Credit Poin	ts						
7	Gradin រួ Final M	-	kaminatio	n:							
	•	Modul Not Pas		ition (Study Examir	natio	on, Study Exam	nination,	Weigh	t: 100%	, Passed /	

8	Usability of the Module Wahlpflichtmodul. Kann als Ausgangspunkt einer Bachelorarbeit dienen.
9	Literature wird je nach Thema spezifiziert
10	Comment Verantwortlich: Studiendekan

Мо	dule nam	ne								
	Math	nematic	s I		-					
Module no. 04-00- 0125/f		Points 7 CP			-study Duration 135 h 1 Semes				ency 2. semester	
	guage of man	Instruct	ion			on responsib . Dr. rer. nat.			le	
1	Course	s of the	Module							
	Course no.		Course	name		Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-00-0	118-vu	Mathem	atics I	0		Lecture and Exercise		5	
2	geomet of one mean v of one integra	nentals: try, conv variable: alue the variable: ls, appro quation;	ergence continu orems, e fundam ximatior	and vectors, equat of sequences, elem ity and differentiabi xtremal problems, i ental theorem of ca techniques; Linear tics: combinatorics,	entar ility, i invers Ilculu Alge	y functions; on termediate se functions; s, rules of int bra: matrices	differenti value and integral c egration, , systems	al calcu d alculus impro	ulus s	
3	Learning Outcomes Nach Abschluss des Moduls können die Studierenden - die grundlegenden Begriffsbildungen und Resultate der Vektorrechnung und der Linearen Algebra wiedergeben und anwenden, - die grundlegenden Begriffsbildungen und Resultate der Analysis von Funktionen einer Veränderlichen wiedergeben und die wichtigsten zugehörigen rechnerischen Methoden									

	anwenden,
	- erste elementare Ergebnisse der Stochastik wiedergeben und anwenden,
	Die Studierenden sollen
	 Kenntnisse über die wechselseitigen Beziehungen der Vektorrechnung und Linearen Algebra und ihre geometrische Bedeutung erwerben,
	- die Rolle der Analysis in den Natur- und Ingenieurwissenschaften erkennen,
	- die Bedeutsamkeit und Zuverlässigkeit der erlernten Rechenmethoden beurteilen können,
	 die Grundvoraussetzungen erwerben, um sich im späteren Studium und Beruf benötigte weitergehende mathematische Kenntnisse selbst erarbeiten zu können.
4	Requirements for Participation keine
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	JBA, B.Sc. Sportwissenschaft und Informatik, B.Ed.Metall: Pflicht
9	Literature
10	Comment

Мо	dule nan	ne								
	Math	nematic	s I							
04-	dule no. 00- 25/s	Credit F	Points 7 CP	Workload 210 h		Self-study Duration 135 h 1 Semest		•		n cy 2. semester
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ule	
Ger	man				Prof.	Dr. rer. nat.	Marc Pfe	tsch		
1	Course	s of the	Module							
	Course no. Course		name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0	118-vu	Mathem	atics I		0		Lecture Exercis		5
	integra linear e distribu	ls, appro quation; itions	ximatior Stochas	ental theorem of can techniques; Linear tics: combinatorics	r Algek	ora: matrices	, systems	5	•	
3		i g Outco bschluss		duls können die Stu	dierer	nden				
	- die gr	undleger	nden Beg	griffsbildungen und nd anwenden,			orrechnu	ing und	d der Lir	iearen
	-	erlichen		griffsbildungen und eben und die wicht			•			
	- erste	element	are Ergel	onisse der Stochast	ik wie	dergeben un	d anwend	den,		
	Die Stu	dierende	en sollen							
				echselseitigen Bezie Bedeutung erwerbe		en der Vekto	rrechnun	g und I	Linearer	n Algebra

	- die Rolle der Analysis in den Natur- und Ingenieurwissenschaften erkennen,
	- die Bedeutsamkeit und Zuverlässigkeit der erlernten Rechenmethoden beurteilen können,
	 die Grundvoraussetzungen erwerben, um sich im späteren Studium und Beruf benötigte weitergehende mathematische Kenntnisse selbst erarbeiten zu können.
4	Requirements for Participation keine
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	JBA, B.Sc. Sportwissenschaft und Informatik, B.Ed.Metall: Pflicht
9	Literature
10	Comment

Mod	dule nan	ne										
	Math	nematic	s II									
Мос	dule no.	Credit F	Points	Workload		Self-	study		Duration		Frequen	cy
04-0	0-0126		4 CP		120 h			75 h	1 Semest	er	Every 2.	semester
Lang	guage of	Instruct	ion			Pers	on resp	onsib	le for the	Modu	ıle	
Gerr	man					Prof.	Dr. rer	. nat.	Marc Pfet	sch		
1	Course	s of the	Module									
	Course	no.	Course	name			Workl	oad (O	CP)	Form	of	Contact

				Teaching	Hours per Week
	04-00-0070-vu	Mathematics II	0	Lecture and Exercise	3
2	power series, Fo fields, partial de theorem, optim separation of va	linear mappings, determinant ourier series; differential calcu erivatives, totally differentiable ization with constraints; ordin ariables, linear ODEs, systems o egral calculus: path integrals, p sformations	lus: curves, scalar functions, implic ary differential ec of linear ODEs wit	r and vector cit function quations: th constant	
3	 ein vertieftes V Die Grundzüge wichtigsten zug 	mes des Moduls können die Studie Verständnis der grundlegende e der Analysis von Funktionen ehörigen rechnerischen Methe n Typen von gewöhnlichen Dif	n Begriffe der Lin mehrerer Veränd oden anwenden,	erlichen wiedergeben	und die
	Die Studierende	en sollen			
	- die Rolle der A	nalysis in den Natur- und Inge	nieurwissenschaf	ten erkennen,	
	- die Bedeutsan	nkeit und Zuverlässigkeit der e	rlernten Rechenn	nethoden beurteilen k	können,
		ussetzungen erwerben, um sig mathematische Kenntnisse se			ötigte
Ļ	Requirements f keine	or Participation			
5	Form of Examir Final Module Ex				
	Module	e Examination (Technical Exam	ination, oral / wr	itten Examination, St	andard)
5	Requirements o	on the Award of Credit Points			
7	Grading Final Module Ex	amination:			

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Ed.Metall und B.Sc. Sportwissenschaften und Informatik: Pflicht
9	Literature
10	Comment

IVIC	dule no.	Credit I	Points	Workload	Self	study	Duratio	n	Freque	ncy		
04-	00-0127		8 CP	240 h	0 h 150		2 Semes	ter				
Lar	nguage of	Instruct	tion		Person responsible for the Module							
Ge	rman				Prof	. Dr. rer. nat.	Jan Hend	lrik Bru	inier			
1	Courses of the Module											
	Course	no.	Course	name		Workload ((CP)	Form Teach		Contact Hours per Week		
	04-00-0	067-vu		lgebra II (for Physics a g Degrees (Mathemat		0		Lecture Exercis		3		
	04-00-0	117-vu		lgebra I (for Physics a g Degrees (Mathemat		0		Lecture Exercis		3		
2	vector eigenva	alues, or	thogona	ppings, matrices, ch and unitary transfons, diagonalisation a	ormat	ions, symme				•		
3	Die Stu analytis Orthog	sche Geo onalisier	en kenne ometrie, ^r ung. Sie	en Konzepte, Begriff Vektorräume und li sind befähigt, math er mit den erlernten	neare emat	e Abbildunger ische Lösung	n, Matrize sstrategie	en, Eige en im H	enwerte linblick a	und auf die		

	keine
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test (120 min), except when there
	are only a small number of potential participants. In this case, the exam can be taken in the form
	of an oral exam (30 min). The decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking
	the exam.
6	Requirements on the Award of Credit Points
	Bestehen der Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	Bachelor Physics
9	Literature
	K. Jänich: Lineare Algebra
	G.Fischer: Lineare Algebra
	P. Halmos: Finite-dimensional vector spaces
10	Comment

Мос	dule nan	ne							
	Math	nematics and S	tatistics for Biolo	gists					
Мос	dule no.	Credit Points	Workload	Self-	study	Duration	F	requent	cy
04-0	00-0128	6 CP	180	h	105 h	1 Semest	ter E	very 2. s	semester
Lang	guage of	Instruction		Pers	on responsib	le for the	Module	9	
Gerr	man			Prof	. Dr. rer. nat.	Volker M	artin Bet	tz	
1	Course	s of the Module							
	Course	no. Course	e name		Workload (CP)	Form o	f	Contact

	T			-	
				Teaching	Hours per Week
	04-00-0119-vu	Mathematics and Statistics for Biologists	0	Lecture and Exercise	5
2	and integral cal estimating dens expectation and large numbers a	ions with sets, sequences and in culus; statistical measurements sities; probability measures, ran d variance, independence of rar and central limit theorem; point single factor variance analysis	, calculus of regression dom variables and dis ndom variables, law of	n, tributions,	
3	vertraut gemac Kenntnisse übe mit Punktschätz Tests. Ziel dabe Anwendung und entscheidendes und darauf auft anderseits eine	mes en werden mit einigen grundleg ht und erwerben darauf aufbau r ausgewählte Bereiche der Stat zverfahren, Bereichsschätzverfa i ist einerseits, den Studierende d Interpretation (der Resultate) s Verständnis für die mathemati bauender statistischer Schlussw Reihe von statistischen Verfahr agestellungen (wie z. B. die einf	end grundlegende tistik, insbesondere im hren und statistischer en ein für die richtige von statistischen Verf sche Modellierung de eisen zu vermitteln, un en mit Anwendbarkei	i Zusammenhan T ahren s Zufalls nd t bei	
4	Requirements f Mathematik I	or Participation			
5					
6	Requirements	on the Award of Credit Points			
7	Standar	e Examination (Technical Exami d) e Examination (Study Examinati			-

8	Usability of the Module Pflicht
9	
	Freedman, Pisani, Purves: Statistics. Notron, 1998 Fahrmeir, Künstler, Pigeot, Tutz: Statistik. Der Weg zur Datenanalyse. Springer, 2001 Quinn,
	Keough: Experimental Design and Data Analysis for Biologists. Cambridge, 2007
10	Comment
	Verantwortlich: Herr Betz (sto)

-	dule no.	Credit I		Workload	Self-study	Duration		equency		
04-	00-0129		4 CP	120 h	0 h 75 h 1 Semester Every 2. s					
	guage of rman	Instruct	ion		Person responsit	le for the	Module			
1	Course	s of the	Module							
	Course	no.	Course	name	Workload (CP)	Form of Teachin			
	04-00-0	129-vu	Statistic	s I	0		Lecture a Exercise	nd 3		
	of prob momer	ability (r its); estii :ors); tes	andom v mators (ting (hyp	Ilecting and represe variables, combinate samples, central lim pothesis testing, sign test, distribution te	orics, distribution it theorem. point nificance, error of	and their and interv	val			
		kind, ch								
3	second	kind, ch	mes							
3	second Learnin Vermiti	g Outco lung ein	es breite	en Grundlagenwisse ungen unter Unsich				schem		
3	second Learnin Vermitt mit der oder vo	g Outco Iung ein n Ziel, Er	es breite ntscheid chaftlich	ungen unter Unsiche em Management zu	erheit im technisc I ermöglichen.	nen, unter	rnehmeri	schem		
3	second Learnin Vermitt mit der oder vo Die Stu	g Outco Iung ein n Ziel, Er Ikswirts dierende	es breite htscheide chaftlich en sollen	ungen unter Unsiche em Management zu typische statistisch	erheit im techniscl u ermöglichen. e Probleme des So	nen, unter hätzens u	rnehmeri Ind			
3	second Learnin Vermitt mit der oder vo Die Stu Testens	g Outco Iung ein n Ziel, Er Ikswirts dierende s in tech	es breite ntscheide chaftlich en sollen nischen,	ungen unter Unsiche em Management zu	erheit im technisc u ermöglichen. e Probleme des So chen und ökonom	nen, unter hätzens u ischen Fra	rnehmeri Ind			

4	Requirements for Participation
	keine
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	Pflicht
9	Literature
	Bamberg, G., Bauer, F., Krapp, M.: Statistik, 13. Aufl., Oldenbourg, München,
	2007 Fahrmeir, L., Künstler, R., Pigeot, I. Tutz, G.: Statistik -Der Weg zur Datenanalyse. 4. Aufl., Springer, Berlin 2003 Schira, J., Statistische
	Methoden der VWL und BWL: Theorie und Praxis, 2. Aufl., München
	usw., Pearson Studium, 2005
10	Comment

Мос	dule nam	ne								
	Dida	ctical se	eminar f	or teachers						
Module no. Credit Points Workload			Self-study Dura		Duratior	Ouration		ncy		
04-0	04-00-0135 3 CP		90 h		60 h	1 Semester E		Every 2. semester		
Language of Instruction German 1 Courses of the Module				Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger						
1	Courses of the Module Course no. Course			name	Worklo				Form of Co Teaching H po W	
	04-00-0039-se Seminar for subject-specific didactics: Algebra in schools				0		Semina	ar	2	

	04-00-0109-se	Seminar for subject-specific didactics: Online task training	0	Seminar	2					
	04-00-0112-se	Seminar for subject-specific didactics: Mathematical modeling with students	0	Seminar	2					
	04-00-0159-se	Seminar for subject-specific didactics: Analysis in schools	0	Seminar	2					
	04-00-0160-se	Seminar for subject-specific didactics: Stochastics in schools	0	Seminar	2					
	04-00-0249-se	Seminar for subject-specific didactics: Digital media in mathematical lessons	0	Seminar	2					
	04-00-0290-se	Seminar for subject-specific didactics: Didactics of Probability	0	Seminar	2					
	04-00-0291-se	Seminar for subject-specific didactics: Long-term competence development	0	Seminar	2					
	04-10-0533-se	Seminar for subject-specific didactics: Geometry in schools	0	Seminar	2					
2	Study Content siehe Teilmodu	le								
3	Learning Outco siehe Teilmodu									
4	-	for Participation Grundlagen des Lehrens und Lern	ens von Mathematik"	abgeschlossen						
5	Form of Examin Final Module Ex Modul		ation, oral / written E	xamination, Sta	indard)					
6	Requirements	on the Award of Credit Points								
7	Grading Final Module E • Modul Standa	e Examination (Technical Examin	ation, oral / written E	xamination, We	ight: 100%,					
8	Usability of the Fachdidaktische	e Module es Seminar im Wahlpflichtbereich	n, K-Modul							
9	Literature siehe Teilmodu	le								

Мо	dule nam	ne								
	Algel	braic Nu	umber T	heory						
Мо	dule no.	Credit F	Points	Workload	Self-st	study Duratio		n	Freque	ency
04-0	00-0149		9 CP	270 h		180 h 1 Semester Every 2. se			2. semester	
Lan	guage of	Instruct	ion		Perso	n responsib	le for the	e Modu	ıle	
Ger	man				Prof. [Dr. rer. nat.	Torsten I	Burkha	rd Wed	horn
1	Courses of the Module									
	Course no.		Course name		١	Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	181-vu	Algebrai	c Number Theory	0)		Lecture and Exercise		6
3	Dirichlet unit theorem, extension of Dedekind domains, ramification, global and local fields, adels, idels. Learning Outcomes The students acquire basic techniques and knowledge within the									
	Algebraic Number Theory of number fields and of local fields. They are able to answer typical questions.									
4	Require Algebra		or Partio	ipation						
5			aminatio	on: ation (Technical Exa	aminati	ion, oral / w	vritten Ex	aminat	tion, Sta	andard)
6	Require	ements o	on the A	ward of Credit Poin	nts					
7	Grading Final M	-	aminatio	on:						

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.MCS, B.Sc.WiMa, B.Sc.ME: Wahlpflichtbereich
	Für M.Sc.Math, Vertiefungsbereich, M.Sc.WiMa: Ergänzungsbereich
9	Literature
	(1) J. Neukirch: Algebraic Number Theory, Springer
	(2) S. Lang: Algebraic Number Theory, Addison-Wesley
	(3) J.S. Milne: Algebraic Number Theory, course notes
	(4) D. Zagier: Zetafunktionen und Quadratische Zahlkörper, Springer
	(5) J. Cassels, A. Fröhlich: Algebraic Number Theory, Thompson
10	Comment

Mod	lule nan	ne										
	Parti	al Diffe	rential I	Equations II								
Мос	lule no.	Credit F	Points	Workload		Self-	Self-study Duratio		on Freque		ю	
04-0	0-0153		9 CP	27	70 h		180 h 1 Semes		ster Every 2		semester	
Lang	guage of	Instruct	ion			Person responsible for the Module						
Gerr	man					Prof. Dr. rer. nat. Matthias Hieber						
1	Course	s of the	Module									
	Course no.		Course	e name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0	065-vu	Partial D	ifferential Equati	ions I	I	0			e and e	6	
2	differer have ap	gation of ntial equ oplicatio	ations w ns, for ex	ce, uniqueness a ith functional a kample, in fluid field of interest	nalyt mecl	tical r hanic	nethods. Pre s or material	ference i s science	s given . The o	to equat rientatio	ions that	
3	- are th fields o	f applica	nts famili tion (e.g	ar with current . fluid mechanic unctional analyt	cs, m	ateri	al sciences) a	nd can e	xplain t	hem,		

10	Comment
	Gilbarg, Trudinger: Elliptic Partial Differential Equations of Second Order Amann: Linear and Quasilinear Parabolic Problems Dafermos: Hyperbolic Conservation Laws in Continuum Physics Galdi: An Indroduction to Mathematical Theory of the Navier-Stokes Equations
9	Literature
8	Usability of the Module Consolidation M.Sc.Math.
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
6	Requirements on the Award of Credit Points
	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
5	Form of Examination
4	Requirements for Participation je nach Schwerpunktsetzung: Modul Partielle Differentialgleichungen I, oder Modul Funktionalanalysis + Modul Partielle Differentialgleichungen: klassische Methoden.
	equations and can apply them to simple concrete problems, - they know essential properties of Sobolev spaces and are able to explain their role in the solution theory of partial differential equations. Introduction to modern methods and problems of partial differential equations from different fields of application, secure mastery of functional analytical methods, working in Sobolev spaces

Mod	Module name										
	Mathematical Statistics										
Мос	lule no.	Credit Points	Workload		Self-study	Duration	Frequency				
04-00-0199 9 C		9 CP		270 h	180 h	1 Semester	Every 4. semester				
Lang	guage of	Instruction			Person responsible for the Module						
Gerr	man				Prof. Dr. rer. nat. Michael Kohler						
1	Courses of the Module										

	•								
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week				
	04-00-0073-vu	Mathematical Statistics	0	Lecture and Exercise	6				
2		istributions, VC theory, density confidence intervals, nonparar	•••	mation,					
3	are able to appl to learn new kn Students are ab	mes now and understand the above ly them. They have a deep unte lowledge in this field by themse le to contextualize subject mat and act ethically and responsib	rstanding of Mathema lves. ter within the social co	atical Statistics ar	nd are able				
4	Requirements for Participation recommended: Probability theory								
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 								
6	Requirements o	on the Award of Credit Points							
7	Grading Final Module Ex • Module Standar	e Examination (Technical Exam	ination, oral / written	Examination, We	ight: 100%,				
8	Usability of the M.Sc.Math, M.S	• Module Sc.WiMa: Vertiefungsmodul in S	Stochastik						
9	Literature Witting: Mathe	matische Statistik I							
10	Comment								

Mod	lule nam	ne									
	Algel	oraic Ge	ometry	,							
Мос	lule no.	Credit F	oints	Workload	Self-	study	Duration	ation Freque		ncy	
04-0	0-0222		9 CP	270 h		180 h	1 Semes	ter	Every 2	. semester	
Lang	guage of	Instruct	ion		Person responsible for the Module						
Gerr	man				Prof. Dr. rer. nat. Nils Scheithauer						
1	Courses	s of the	Module					1			
	Course no. Course name			name				Form Teacł	-	Contact Hours per Week	
	04-00-02	221-vu	Algebrai	c Geometry		0		Lecture and Exercise		6	
2	Study Content Affine varieties, projective varieties, morphisms, rational maps, smooth and singular points, plane curves										
3	Learning OutcomesThe students understand the concepts of affine and projective varieties, maps between varieties and singular points. They have basic knowledge in the theory of curves. They are able to solve geometric problems with the presented methods.Requirements for Participation										
	Algebra	l									
5			aminatio	on: nation (Technical Exa	amina	ntion, oral / w	vritten Ex	aminat	ion, Sta	indard)	
6	Require	ements o	on the A	ward of Credit Poin	ts						
7	Grading Final M	odule Ex		on: nation (Technical Exa	amina	ntion, oral / w	vritten Ex	aminat	ion, We	ight: 100%,	
8		-	Module B.Sc.Ma	th.(bilingual), B.Sc.N	лсs, I	B.Sc.WiMa, B	.Sc.ME:				

)	Literature
	K. Hulek, Elementary algebraic geometry, AMS
	R. Hartshorne: Algebraic geometry, Springer
	I. R. Shafarevich: Basic algebraic geometry 1,2
	Comment

Mo	dule nam Math	-	al Found	dations of	CS						
Mo	dule no.	Credit F	Points	Workload		Self	-study Duratio		า	Freque	ency
04-0	00-0233		9 CP		270 h		180 h	2 Semes	ter	Every 2	2. semester
	guage of man	Instruct	ion			Person responsible for the Module Prof. Dr. rer. nat. Martin Otto					
1	Courses of the Module										
	Course	no.	Course	urse name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	090-vu	Propositional Logic and Predicate Logic			0		Lecture and Exercise		3	
	04-00-0	091-vu	Automata, Formal Languages and Decidability			and	0		Lecture Exercis		3
2	Theore lemmas and rec proposi first-ord compac undecid	utomata m, gram s, model ursive el tional lo der logic ctness th dability c	mars and s of com numerab gic: com : structur eorem, p of first-or	d Chomsky h putation, PE vility; pactness, co res and assig	iierarch DA, Turii omplete gnment , Gödel'	y, cor ng ma proc s, Skc s con	lemisation, H	guages, p lability Ierbrand	oumpin	-	
3	Learning Outcomes Die Studierenden können die einschlägig Beweistechniken aus diskreter Mathema der mathematischen Grundlagen der the interpretieren, einordnen und anwender die Grundlagen der Analyse formaler Spr					und etisch nsbes	Logik im Zusa nen Informati sondere behe	mmenha k rrschen s	-		

	Berechnungsmodelle. Sie können die Grundbegriffe
	der mathematischen Logik anhand typischer Fragestellungen
	der theoretischen Informatik erläutern, auf Beispiele anwenden,
	algorithmische Methoden diskutieren und deren Grenzen anhand
	einschlägiger Sätze illustrieren.
4	Requirements for Participation
	allg. mathematisches Grundwissen
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	Wahlpflicht im Bachelorstudiengang Mathematik
9	Literature
	Hopcroft, Motwani, Ullman: Einführung in die Automatentheorie, formale
	Sprachen und Komplexitätstheorie
	Schöning: Theoretische Informatik – kurz gefasst
	Boolos, Burgess, Jeffrey: Computability and Logic
	Burris: Logic for Mathematics and Computer Science
	Skripte (elektronisch unter www.mathematik.tu-darmstadt.de/~otto)
10	Comment

Module nam	ne					
Inter	national Intern	et Seminar				
Module no.	Credit Points	Workload		Self-study	Duration	Frequency
04-00-0239	9 CP		270 h	180 h	1 Semester	Irregular
Language of	Instruction			Person responsib	le for the Modu	ıle
English				Prof. Dr. rer. nat.	Robert Haller	

1	Courses of the	Module			
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0237-vu	International Internet Seminar	0	Lecture and Exercise	6
2	relevant for act semigroup theo	ledge from functional analysis a ual research, is introduced. Poss ory, heat kernels, form methods, tial equations, regularity theory,	ible topics are and w control theory, grad	ere among othe ient systems, sto	rs:
3	- apply these m problems - assess the sco		ntial equations and s	•	
4	-	for Participation Functional Analysis			
5	Fachprüfung: U small number o exam. The decis		of a written test, exc ase, the exam can be is taken and commu	ept when there taken in the for nicated during t	are only a m of an oral he first two
6	Requirements of Passing the Fac	on the Award of Credit Points hprüfung			
7	Grading Final Module Ex Module Standar	e Examination (Technical Exami	nation, oral / written	Examination, W	eight: 100%,
8	Usability of the B.Sc Mathemat	e Module ik, M.Sc. Mathematik, M.Sc. Ma	thematics		
9	Literature lecture notes				

10	Comment recommended: Mathematics: Master (ana)

Mo	dule nan	ne								
	Pract	ical Stu	dies in (CE						
Mo	dule no.	Credit P	oints	Workload	Self-	study	Duratior	ו	Freque	ncy
04-0	00-0267		4 CP	120 h		90 h	1 Semes	ter	Every 2	. semester
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ıle	
Ger	man				Prof.	Dr. rer. nat.	Jan Giess	elman	n	
1	Course	s of the I	Module			1		1		
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	264-pr	Practical	Studies in CE		0		Project	t	2
2	Study C	Content								
3	Learnin	g Outco	mes							
4	Require	ements f	or Partic	ipation						
5	Form o	f Examin	ation							
	Final M	odule Ex	aminatio	on:						
	•	Module Passed)		ation (Study Exami	natior	n, oral / writte	en Exami	nation,	, Passed	/ Not
6	Require	ements o	on the Av	ward of Credit Poin	ts					
7	Grading	-								
	Final M	odule Ex	aminatio	on:						
	•		e Examin / Not Pa:	ation (Study Examinessed)	natior	n, oral / writt	en Examii	nation,	, Weight	: 100%,
8	Usabili	ty of the	Module							

9	Literature
10	Comment

Мо	dule nam	ne								
	PDE	ll.F Ana	lysis of	Reaction Diffusior	n System	S				
Мо	dule no.	Credit F	Points	Workload	Self-stud	dy	Duration	า	Freque	ncy
04-(00-0271		5 CP	150 h		105 h	1 Semes	ter	Irregula	ar
Lan	guage of	Instruct	ion		Person r	esponsib	le for the	e Modu	ıle	
Ger	man and	English			Prof. Dr.	rer. nat.	Dieter Bo	othe		
1	Course	s of the l	Module							
	Course	no.	Course	name	Wo	orkload ((CP)	Form Teach		Contact Hours per Week
	04-00-0	268-vu		Analysis of Reaction Systems	0			Lecture Exercis		3
3	system:	g Outco	mes							
	Studen	ts learn t	:0							
	- derive	e prototy	pe mode	els for reaction diffu	ision syste	ems				
				usion systems as at			•			
	- to app system	•	emigroup	o approach for semi	linear evo	plution ed	quations t	o reac	tion diff	usion
	-		e concer	ot of flow invariance	e and to a	oply it to	reaction	diffusi	on svste	
			•							ms
		stand th	e fundar	nental problems co	ncerning	the globa	l existenc	ce of so	olutions	
				ns for prototype ca	-	the globa	l existenc	ce of sc	olutions	
4	overco Require	me these	e probler	ns for prototype car cipation	ses	the globa	l existenc	ce of so		
4	overco Require	me these	e probler	ns for prototype ca	ses	the globa	l existenc	ce of so	blutions	ms and how to

Final Module Examination:

• Module Examination (Technical Examination, oral / written Examination, Standard)

Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.

6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	 Literature A.Pazy: Semigroups of linear operators and applications to Partial Differential Equations, Springer 1983. J. Prüss, Maximal regularity for evolution equations in Lp-spaces. Lecture Notes, Monopoli 2002. L. Lorenzi, A. Lunardi, G. Metafune, D. Pallara: Analytic Semigroups and Reaction-Diffusion Problems, Internet Lecture Notes 2005.1983. M. Pierre. Global existence in reaction-diffusion systems with control of mass: a survey. Milan J. Math., 78, 417-455, 2010.
10	Comment recommended: Mathematics: Master (ana) Builds on "Partial Differential Equations I". Upon approval, contents of two PDE II.X-courses may replace "Partial Differential Equations II" and can be combined with the content from "Partial Differential Equations I" as an "Advanced Course in Analysis". Combinations of two or more PDE II.X-courses as additional courses require approval, too.

Module nam	ie						
Gam	e Theory						
Module no.	Credit Points	Workload		Self-study		Duration	Frequency
04-00-0281	6 CP		180 h		135 h	1 Semester	Every 2. semester

Lan	guage of Instruc	tion	Pers	on responsible for	the Module	
Ger	man		Prof	. Dr. rer. nat. Stefa	n Ulbrich	
1	Courses of the	Module				
	Course no.	Course name		Workload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0277-vu	Game Theory		0	Lecture and Exercise	3
2	of solution of a (e.g. Brouwer), zero-sum game systems).	ve game theory: sequential a game (e.g. Nash equilibriun existence theorems (e.g. mi es) and impossibility theoren me theory: coalitions, soluti	n), fixe inimax ns (e.g	ed point theorems k theorem for two- g. Arrow paradox for	player or voting	nvex games,
3	Spieltheorie. Si abstrakter Beg	omes verstehen grundlegende Kon ie modellieren einfache konk riffe. Sie wenden mathemati e Vorhersagen für die Praxis	krete S ische ⁻	Situationen unter \	/erwendung präz	iser und
ļ	-	for Participation athematisches Grundwissen	i aus d	en Fachsemestern	1-3	
5	Form of Exami Final Module E • Modu		amina	ation, oral / writter	n Examination, St	tandard)
5	Requirements	on the Award of Credit Poir	nts			
7	Grading Final Module E	xamination:				
	• Modu Standa	le Examination (Technical Ex rd)	amina	ation, oral / writter	n Examination, W	'eight: 100%
3	Usability of the B.Sc.Math:Wał	e Module hlpflichtbereich, Ergänzungsl	bereic	h		
9	Literature W. Krabs: Spiel	theorie: Dynamische Behan	dlung	von Spielen. Verla	g B.G. Teubner 20	005
	Osborne, Mart	in J. (2004), An introduction	to gar	ne theory		

10	Comment

_	Treff	punkt N	/lathem	atik II für ET				
Мо	dule no.	Credit F	Points	Workload	Self-study	Duration	Fr	requency
04-	00-0297		0 CP	0 h	0 h	1 Semeste	er Ev	very 2. semeste
	guage of man	Instruct	ion		Person responsit	le for the	Module	
1	Courses	s of the	Module					
	Course	no.	Course	name	Workload (-	Form of Teachin	
	04-10-04	405-tt	Treffpun	kt Mathematik II für I	ET 0	C	Conventio	on O
2	Study C	Content						
3	Learnin	g Outco	mes					
4	Require	ements f	or Partio	ipation				
5	Form o	f Examir	nation					
5				ward of Credit Poin	ts			
		ements o		ward of Credit Poin	ts			
6	Require Grading	ements o g			ts			

Mo	dule nam Treff		Mathem	atik II für Informa	tik und '	Wirtscha	aftsinfor	matik			
Mo	dule no.	1		Workload	Self-stu		Duratio		Frequ	ency	
04-(00-0298		0 CP	0 h		0 h	1 Seme	ster	Every	2. semester	
	guage of man	Instruct	tion		Person ı	esponsit	le for th	e Modı	ule		
1	Course	s of the	Module								
	Course	no.	Course	name	W	Workload (CP)			Form of Teaching		
	04-10-0	403-tt	Informat	kt Mathematik II für ik und iftsinformatik	0			Conve	ntion	0	
2 3	Study C	ontent	omes								
4	Require	Requirements for Participation									
5	Form o	f Examiı	nation								
6	Require	ements	on the Av	ward of Credit Poin	ts						
7	Gradin	g									
8	Usabilit	ty of the	e Module								
9	Literatu										

Мо	dule nam	ne								
	Treff	punkt N	/lathem	atik für ET						
Мо	dule no.	Credit F	Points	Workload	Self-study Duratio			า	Frequ	ency
04-0	00-0300		0 CP	0 h		0 h	1 Semes	ter	Every	2. semester
Lan	guage of	Instruct	ion		Perse	on responsib	le for the	e Modu	ule	
Ger	man				Studi	iendekan*in	des Fach	bereicł	ns 04	
1	Course	s of the l	Module							
	Course no. Course no. 04-10-0404-tt Treffounk:		name		Workload (CP)		Form Teach	-	Contact Hours per Week	
	04-10-0404-tt Treffpunkt Mathematik I für				Т	0		Conve	ntion	0
2	Study C									
3		g Outco								
4	Require	ements f	or Partic	ipation						
5	Form o	f Examir	nation							
6	Require	ements o	on the Av	ward of Credit Poin	ts					
7	Gradin	5								
8	Usabili	ty of the	Module							
9	Literatu	ıre								
10	Comme	ent								
	Verant	wortlich:	Studien	dekan						

Mod	lule nam	ne										
		-		atik für Informat			chaft					
	lule no.	Credit F		Workload		-				Frequency		
04-0	0-0301		0 CP	01	1		0 h	1 Semes	ster	Every 2	2. semester	
-	uage of	Instruct	ion			-		le for the				
Gerr					Stud	diendeka	an*in	des Fach	bereich	ns 04		
1	Courses	s of the	Module			-			T			
	Course	no.	Course	name					Form Teach	-	Contact Hours per Week	
	04-10-04	402-tt	Information	ıkt Mathematik I für tik und aftsinformatik		0			Conver	ntion	0	
2	Study C	Content										
3	Learning Outcomes											
4	Require	ements f	or Partio	cipation								
5	Form of	f Examir	ation									
6	Require	ements o	on the A	ward of Credit Poi	nts							
7	Gradin	3										
8	Usabilit	ty of the	Module	2								
9	Literatu	ıre										
10	Comme	ent										
	Verantv	wortlich:	Studien	dekan								

Мо	dule nan	ne								
	Treff	punkt M	Mathem	atik für Maschine	enbau	I				
Мо	dule no.	Credit I	Points	Workload	Self-	study	Frequ	equency		
04-(00-0302		0 CP	0 h		0 h	1 Semes	ter	Every	2. semester
Lan	guage of	Instruct	tion			on responsib				
Ger	man				Stud	iendekan*in	des Fach	bereicl	ns 04	
1	Course	s of the	Module			1				
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0406-tt Treffpunkt Mathematik I für 0 Convention 0 Maschinenbau								0	
2	Study (Content								
3	Learnin	g Outco	omes							
4	Require	ements	for Partio	cipation						
5	Form o	f Examiı	nation							
6	Require	ements	on the Av	ward of Credit Poir	its					
7	Gradin	8								
8	Usabili	ty of the	e Module							
9	Literati	ıre								
10	Comme Veranty		: Studien	dekan						

Mo	dule nan	ne									
	Treff	punkt l	Mathem	atik II für Maschi	nenba	au					
	dule no.	Credit		Workload		Self-study Duration Frequency					
	00-0303		0 CP	0 h			1 Semes			2. semester	
	guage of	Instruc	tion			on responsib					
	man				Stud	iendekan*in	des Fach	bereich	าs 04		
1			Module					1_		Contact	
	Course	no.	Course name			Workload (CP)			Form of (Teaching 		
	04-10-0	407-tt	Treffpun Maschin	ıkt Mathematik II für enbau		0		Conve	ntion	0	
2	Study C	Content									
3	Learning Outcomes Requirements for Participation										
5	Form o	f Exami	nation								
6	Require	ements	on the A	ward of Credit Poin	ts						
7	Gradin	g									
8	Usabili	ty of the	e Module	1							
9	Literati	ure									
10	Comme Veranty		: Studien	dekan							

Mod	lule nam	ne									
	lule no.	ll - Semi Credit P	Points	subject-specific d Workload	Self-s	tudy	Duratio		Freque	•	
	0-9990		0 CP	0 h			1 Semes			semester	
-	-	Instruct	ion			n responsi					
Gern					Studie	endekan*ir	i des Fach	bereich	ns 04		
1	Course: Course	s of the I no.	Module Course	name	,	Workload ((CP)	Form Teach		Contact Hours per Week	
2	Study C	Content									
3	Learning Outcomes										
4	Require	ements f	or Partio	ipation							
5			aminatio	on: ation (Study Examii	nation,	Special Fo	rm, Passe	ed / No	t Passed	(k	
6	Require	ements o	on the A	ward of Credit Poin	ts						
7	Gradinį Final M	odule Ex		on: ation (Study Examin	nation,	Special Fo	rm, Weigł	nt: 100	%, Passe	ed / Not	
8	Usabilit	ty of the	Module								
9	Literatı	ıre									
10	Comme										
	Verant	wortlich:	Studien	dekan*in des Fachb	ereich	s 04					

Mod	lule nam	ie											
	Signa	l - No c	onditio	ns or requirement	s fuli	filled							
Mod	lule no.	Credit F	oints	Workload	Self-	study	Duration	า	Frequency				
04-0	0-9997		0 CP	0 h		0 h 1 Semester Every semester							
Lang	uage of	Instruct	ion			on responsib							
Gerr					Stud	iendekan*in	des Facht	pereich	ns 04				
1	Courses	s of the l	Module					1		ſ			
	Course	no.	Course	name		Workload ((CP)	Form Teach		Contact Hours per Week			
2	Study Content												
3	Learning Outcomes												
4	Requirements for Participation												
5		f Examin odule Ex	a tion aminatio	on:									
	•	Module	e Examir	nation (Study Examin	natior	n, Special For	m, Passe	d / No	t Passed)				
6	Require	ements o	on the A	ward of Credit Poin	ts								
7	Grading Final M	odule Ex		on: nation (Study Examin	natior	n, Special For	m, Weigh	t: 1009	%, Passec	l / Not			
8	Usabilit	y of the	Module	2									
9	Literatı	ire											

Мо	dule nan	ne										
		gual vali			1		1					
	dule no.	Credit P		Workload	Self-study Duration Freque					-		
	00-9998		0 CP	0 h			1 Semest		-	2. semeste		
	guage of	Instruct	ion			responsib						
	man				Studier	idekan*in	des Facht	bereich	ns 04			
1	Course	s of the I	Vodule									
	Course no. Course name					Workload (CP) Forr Tead				Contact Hours per Week		
2	Study C	Content										
3	Learnin	Learning Outcomes										
4	Require	ements f	or Partio	cipation								
5		f Examin odule Ex Module	aminatio	on: ation (Study Exami	nation, S	tudy Exan	nination,	Passed	d / Not I	Passed)		
6	Require	ements o	on the Av	ward of Credit Poin	ts							
7	Grading Final M	odule Ex Module	e Examin	on: hation (Study Exami	nation, S	tudy Exan	nination, N	Neight	t: 100%,	Passed /		
		Not Pas										
8	Usabili	ty of the	Module									
9	Literatu	ire										

10	Comment
	Verantwortlich: Studiendekan

	dule nam Valid	lation										
Мо	dule no.		oints	Workload	Self-study	Duration	Freque	ncv				
	00-9999		0 CP	0 h	-	1 Semester	-	emester				
	guage of	Instructi	ion		Person responsib							
	man	<i></i>			Studiendekan*in	des Fachbere	ichs 04					
1	Course	s of the N no.	Course	name	Workload (CP) Form of Contac Teaching Hours per Week							
2	Study C	Study Content										
3	Learning Outcomes											
4	Requirements for Participation											
5		f Examin odule Ex Module	aminatio	on: nation (Study Exami	nation, Study Exam	nination, Pass	ed / Not F	Passed)				
6	Require	ements o	on the A	ward of Credit Poin	ts							
7	Grading Final M	odule Ex	e Examir	on: nation (Study Exami	nation, Study Exam	nination, Weig	ht: 100%,	Passed /				

9	Literature
10	Comment Verantwortlich: Studiendekan

Mo	dule nam	ne										
	Signa	al - no ci	rculatio	n	1							
Мо	dule no.	Credit F	oints	Workload	Self-s	elf-study Duration			Frequen	су		
04-0	01-0000		0 CP	0 h		0 h	1 Semest	ter	Every se	mester		
Lan	guage of	Instruct	ion		Perso	on responsib	le for the	Modu	le			
Ger	man				Studi	endekan*in	des Facht	pereich	ns 04			
1	Course	s of the l	Module					I		1		
	Course	no.	Course	name		Workload (0	CP)	Form Teacł	-	Contact Hours per Week		
2	Study Content											
3	Learning Outcomes											
4	Require	ements f	or Partic	ipation								
5	Form o	f Examin	ation									
	Final M	odule Ex	aminatio	on:								
	•	Module	e Examin	ation (Study Exami	nation	, Special For	m, Passe	d / No	t Passed)			
6	Require	ements o	on the Av	ward of Credit Poin	its							
7	Grading Final M	odule Ex		on: ation (Study Exami	nation	, Special For	m, Weigh	t: 1009	%, Passec	l / Not		
8	Usabilit	ty of the	Module									

9	Literature
10	Comment
	Verantwortlich: Studiendekan

	Stati	stics I										
Module no. Credit Points Workload					Self-study		Duratio	Duration		Frequency		
			240 h	-		1 Semes			Every 2. semester			
Language of Instruction					Person responsible for the Module							
Ger	man				Prof. Dr. r	er. nat.	Michael	Kohler				
1	Courses of the Module											
	Course	no.	Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-00-0116-vu S		Statistics I		0	0		Lecture and Exercise		5		
	 Statistische Masszahlen Dichteschätzung und Wahrscheinlichkeitsmaße Zufallsvariablen und Verteilungen Erwartungswert und Varianz Unabhängigkeit Gesetz der großen Zahlen und zentraler Grenzwertsatz Punktschätzverfahren und statistische Tests, insbesondere Gauß und t-Test 											
3	Die Stu Modell	ierung d	en verfüg es Zufalls	gen über ein grundle s und darauf aufbau Masszahlen, zur Di	iender stat	istische	r Schluss	weisen	. Sie hal	pen ein		

	verstehen das Prinzip eines statistischen Tests.
4	Requirements for Participation Keine
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflicht
9	Literature Agresti, A. and Tinlay, B. Statistical Methods for the Social Sciences. Prentice Hall. 2009. Eckle-Kohler, J. and Kohler, M. Eine Einführung in die Statistik und ihre Anwendungen. Springer. 2009.
10	Comment Verantwortlich: Herr Kohler (sto)

	Anal	ysis I									
04-	dule no. 10- 01/de	Credit F	Points 9 CP	Workload	270 h	Self-stu	•	Duratior 1 Semes	-	Frequ Every	ency 2. semester
Language of Instruction German						Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber					
1	Courses of the Module										
	Course no. C		Course	se name		w	Workload (CP)		Form of Teaching		Contact Hours per Week

	04-00-0003-tt	Analysis I	0	Convention	1					
	04-00-0003-vu	Analysis I	0	Lecture and Exercise	6					
2	Study Content Real and complex numbers, completeness, convergence of sequences and series, topology of the real numbers, compactness, notion of a function, continuity, elementary functions, differentiation, Mean Value Theorem, Taylor's Theorem, integral, Fundamental Theorem of Calculus, techniques of integration.									
3	Learning Outcomes After the completion of this course, the students are able to -analyse functions in one real variable using fundamental concepts such as limit, continuity, differentiability and Riemann integrability -prove mathematical results in this context with different methods of proof									
4	Requirements none	for Participation								
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture. 									
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung									
7	Passed	le Examination (Study E) le Examination (Technic		orm, Weight: 0%, Passed written Examination, W						

8	Usability of the Module B.Sc. Mathematik, LaG Mathematik, B.Sc. Physik
9	Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I, II. Vieweg M. Hieber: Analysis I, Springer K. Königsberger: Analysis 1, 2, Springer Charles R. MacCluer, Honors Calculus, Princeton Univ. Press W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment recommended: Mathematics: Bachelor year 1, Teaching Degrees

	Anal	ysis I (er	nglish)									
Module no. 04-10- 0001/en		Points Workload 9 CP 270 h		Self-	Self-study Duration 165 h 1 Semes		•		ency 2. semestei			
Language of Instruction English					on responsib . Dr. rer. nat.							
1	Course Course	s of the I no.	Module Course	name			Workload (CP)	Form	of	Contact	
									Teaching		Hours per Week	
	04-00-0040-tt		Analysis I (english)				0		Convention		1	
	04-00-0040-vu Analys		Analysis	is I (english)			0		Lecture and Exercise		6	
2	Real an the rea differen	l number ntiation,	rs, comp Mean Va	ers, complete actness, notic alue Theorem integration	on of a	func	tion, continu	ty, eleme	entary	function	s,	
3	Learning Outcomes After the completion of this course, the students are able to											
3	After th	ic compi	- analyse functions in one real variable using fundamental concepts such as limit, continuity, differentiability and Riemann integrability									

4	Requirements for Participation
•	none
5	Form of Examination Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung;
	Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
-	B.Sc. Mathematik, LaG Mathematik, B.Sc. Physik
9	Literature
	H. Amman, J. Escher: Analysis II, Birkhäuser
	O. Forster: Analysis I, II. Vieweg
	M. Hieber: Analysis I, Springer K. Königsberger: Analysis 1, 2, Springer
	Charles R. MacCluer, Honors Calculus, Princeton Univ. Press
	W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment
	recommended: Mathematics: Bachelor year 1

Mo	dule nam	ne									
	Anal	ysis II									
Module no. 04-10- 0002/deCredit Points 9 CPWorkload270 h			Self-study 165 h	Duration 1 Semester		requen very 2.	ency 2. semester				
Language of Instruction German					Person responsik Prof. Dr. rer. nat.			9			
1	Course	s of the	Module								
	Course	no.	Course	name	Workload (,	Form of Teaching		Contact Hours per Week		
	04-00-0	002-tt	Analysis	II	0	Co	onventio	on	1		
	04-00-0	002-vu	Analysis	11	0	_	ecture a kercise	and	6		
	Höhere Ableitungen und Satz von Taylor in mehreren Variablen Lokale Extrema Lokale Umkehrbarkeit und implizite Funktionen Kurven, Wege und Vektorfelder Konvergenz von Fourrierreihen Parsevalsche Gleichung										
3	After th -analyse in norm	e functio ned spac	letion of ons in sev es, partia	this course, the stu- veral real variable us al and total differen properties in higher	sing fundamental tiability and integr	ability					
4	-		f or Partic Analysis	-							
5		 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) 									
	•	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)									

	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.									
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.									
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung									
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 									
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik, B.Sc. Physik									
9	Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis I, Springer K. Königsberger: Analysis 1,2, Springer W. Rudin: Principles of Mathematical Analysis, McGraw-Hill									
10	Comment recommended: Mathematics: Bachelor year 1, Teaching Degrees									

Module nam	Module name										
Analy	Analysis II (english)										
Module no. 04-10- 0002/en	Credit Points 9 CP	Workload	270 h	Self-study 165 h	Duration 1 Semester	Frequency Every 2. semester					
Language of English	Instruction			Person responsible for the Module Prof. Dr. phil. nat. Ulrich Kohlenbach							

1	Courses of the	Module									
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-00-0011-tt	Analysis II (english)	0	Convention	1						
	04-00-0011-vu	Analysis I (englisch)	0	Lecture and Exercise	6						
2	Study Content Konvergenz von Funktionenfolgen, Potenzreihen, Topologie metrischer Räume, Normen, Differentialrechnung mehrerer Variablen, partielle Ableitungen, Ableitungsregeln, Gradient, Höhere Ableitungen und Satz von Taylor in mehreren Variablen Lokale Extrema Lokale Umkehrbarkeit und implizite Funktionen Kurven, Wege und Vektorfelder Konvergenz von Fourrierreihen Parsevalsche Gleichung										
3	After the comp - analyse funct in normed space - investigate ge Requirements	Learning Outcomes After the completion of this course, the students are able to - analyse functions in several real variable using fundamental concepts such as norms, continuity in normed spaces, partial and total differentiability and integrability - investigate geometric properties in higher dimensional spaces using basic topological concepts Requirements for Participation									
	recommended	·									
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) 										
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.										
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.										
				-	d the						

	Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik, B.Sc. Physik
9	Literature H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I amp; II. Vieweg M. Hieber: Analysis II, Springer K. Königsberger: Analysis 1,2, Springer W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment recommended: Mathematics: Bachelor year 1

Mod	lule nam	ne								
	Analy	ysis								
Module no. 04-10- 0003/de		Points 18 CP	Workload	540 h	study 300 h	Duration 2 Semester		Frequency Every 2. semeste		
Language of Instruction German						on responsib Dr. rer. nat.				
1	Courses	s of the	Module							
	Course no. Course			se name		Workload ((CP)	Form Teach	•••	Contact Hours per Week
	04-00-0	002-tt	Analysis	is II		0		Convention		2
	04-00-00	04-00-0002-vu Analysis		s II		0		Lecture and Exercise		6
	04-00-0	003-tt	Analysis	ysis l		0		Convention		2
	04-00-0003-vu Analysis		Analysis	s l		0		Lecture Exercis		6

2	Study Content Part 1: Real and complex numbers, completeness, convergence of sequences and series, topology of the real numbers, compactness, notion of a function, continuity, elementary functions, differentiation, Mean Value Theorem, Taylor's Theorem, integral, Fundamental Theorem of Calculus, techniques of integration. Part 2: Convergence of sequences of functions, power series, topology of metric spaces, norms on Rn, differentiation of functions of several variables, partial derivatives, rules of differentation, gradient, higher derivatives and Taylor's theorem in several variables, local extrema, inverse and implicit function theorems, integration on Rn, curves in Rn, integral theorems of Gauß and Stokes
3	Learning Outcomes Teil 1: Nach dem Besuch des Moduls können die Studierenden - Funktionen einer reellen Variablen mit grundlegenden Konzepten (Grenzwert, Stetigkeit, Differenzierbarkeit, Vollständigkeit usw.) analysieren - mathematische Schlussfolgerungen mit verschiedenen Beweismethoden herleiten Teil 2: Nach dem Besuch des Moduls können die Studierenden - Funktionen, die von mehreren Variablen abhängen, mit grundlegenden Konzepten (Stetigkeit, totale und partielle Differenzierbarkeit, Integration) analysieren - geometrische Zusammenhänge in mehrdimensionalen Räumen mit topologischen Grundkonzepten untersuchen
4	Requirements for Participation keine
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module 1. Jahr Bachelor
9	Literature O. Forster: Analysis I, II. Vieweg

	H. Heuser: Lehrbuch der Analysis 1, 2, Teubner K. Königsberger: Analysis 1, 2, Springer Charles R. MacCluer, Honors Calculus, Princeton Univ. Press W. Rudin: Principles of Mathematical Analysis, McGraw- Hill
10	Comment

Мо	dule nam	ne								
	Analy	ysis (en	glish)							
Module no. 04-10- 0003/en		Points Workload 540 h		Self	Self-study Durati 300 h 2 Semo		•		ency semester	
Language of Instruction English						on responsib . Dr. rer. nat.				
1	Course	s of the	Module							
	Course	no.	Course name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	011-tt	Analysis II			0			ntion	2
	04-00-0011-vu		Analysis II			0		Lecture and Exercise		6
	04-00-0040-tt		Analysis I			0		Convention		2
	04-00-0040-vu		Analysis I		0			Lecture and Exercise		6
2	series, f elemen integra Part 2: spaces, rules of several	Real and topology tary fun l, Fundar Converg norms o differer variable	y of the rections, d mental T mence of s on Rn, dif ntation, g es, local e	x numbers, complet eal numbers, compa ifferentiation, Mear heorem of Calculus, sequences of function fferentiation of function gradient, higher der extrema, inverse and gral theorems of Ga	actne n Vali , tech ons, p ctions ivativ d imp	ess, notion of ue Theorem, nniques of into power series, s of several va res and Taylor plicit function	a functio Faylor's T egration topology triables, p t's theore	n, cont heorer of met partial o em in	inuity, n, tric derivativ	es,
3	Teil 1: N - Funkti Differei	onen ei nzierbar	n Besuch ner reelle keit, Voll	n des Moduls könne en Variablen mit gru ständigkeit usw.) ar sfolgerungen mit ve	indle nalysi	genden Konze eren	epten (Gi		-	skeit,

	Teil 2: Nach dem Besuch des Moduls können die Studierenden - Funktionen, die von mehreren Variablen abhängen, mit grundlegenden Konzepten (Stetigkeit, totale und partielle Differenzierbarkeit, Integration) analysieren - geometrische Zusammenhänge in mehrdimensionalen Raeumen mit topologischen Grundkonzepten untersuchen
4	Requirements for Participation keine
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module 1. Jahr Bachelor
9	Literature O. Forster: Analysis I, II. Vieweg H. Heuser: Lehrbuch der Analysis 1, 2 Teubner K. Königsberger: Analysis 1, 2, Springer Charles R. MacCluer, Honors Calculus, Princeton Univ. Press W.Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment

Module nam	ne				
Linea	ar Algebra I				
Module no.	Credit Points	Workload	Self-study	Duration	Frequency

04-: 000	10- 4/de		9 CP	270 h		165 h	1 Semes	ter	Every	2. semester	
Lan	guage of	Instruct	tion	n Person responsible for the Module							
Ger	man				Prof. Dr. rer. nat. Martin Otto						
1	Courses	s of the	Module								
	Course no.		Course name			Workload (CP)			ı of hing	Contact Hours per Week	
	04-00-0	042-tt	Linear Al	gebra I		0		Conve	ntion	1	
	04-00-0)42-vu	Linear Al	-		0		Lectur Exercis		6	
2	depend	otions ai ence, ba	ases, dim	ots, algebraic struct ension; linear and a natrices; determina	affine				•		
3	axioma geomet	tic treat ric conc ork at a	miliar wit ment to r epts. The	h the basic concep elevant concrete s y can reason and c el. They know and	ettin ondu	gs, problem so oct rigorous ar	olving tas guments	ks and in the	l elemer abstrac	ntary ct axiomatic	
4	Require none	ements	for Partic	ipation							
5	Form o Final M		nation kaminatio	n:							
	•	Modul	e Examin	ation (Study Exami	natio	n, Special For	m, Passe	d / No	ot Passe	d)	
	•		e Examin andard)	ation (Technical Ex	amin	ation, oral / w	vritten Ex	amina	tion, Du	ration 90	
	small n exam. T	umber o he decis he first	of potenti sion abou	e exam is taken in f al participants. In t t the form of the e ks of the lecture, ba	his ca xam	ise, the exam is taken and c	can be ta ommunio	iken in cated	the for	m of an oral	
	of the h	omewo	rk assigni	ments. The precise	prop	ortion of nec	ccessfully completes a certain proportion of necessary assignments and the r during the first lecture.				
6	-		on the Av hprüfung	vard of Credit Poin	ts						

-	Caralian
7	Grading
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	Passed)
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc. Mathematik, LaG Mathematik
9	Literature
	Bosch: Lineare Algebra
	Brieskorn: Lineare Algebra und Analytische Geometrie
	Bröcker: Lineare Algebra und Analytische Geometrie
	Fischer: Lineare Algebra
	Greub: Linear Algebra (auch deutsch)
	Koecher: Lineare Algebra und Analytische Geometrie
10	Comment

Mod	dule nam	ne										
	Linea	ır Algeb	ora I									
Module no. 04-10- 0004/enCredit Points 9 CPWorkload270 h					270 h	Self-studyDurationFrequency165 h1 SemesterEvery 2. seme						
Lang Engl	guage of lish	Instruct	tion				o n responsib Dr. rer. nat.			ıle		
1	Courses	Courses of the Module										
	Course no. Course			se name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0	041-tt	Linear A	lgebra I			0		Convention		1	
	04-00-0041-vu Linear Algebra I					0 Lecture and 6 Exercise					6	
2	Study Content basic notions and concepts, algebraic struct dependence, bases, dimension; linear and a									•		

	space; linear maps and matrices; determinants;
3	Learning Outcomes Students are familiar with the basic concepts of abstract linear algebra. They can relate the axiomatic treatment to relevant concrete settings, problem solving tasks and elementary geometric concepts. They can reason and conduct rigorous arguments in the abstract axiomatic framework at a basic level. They know and can apply and analyse relevant basic constructions in algebra.
4	Requirements for Participation recommended: none
5	Form of Examination Final Module Examination:
	 Module Examination (Study Examination, Special Form, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik
9	Literature Bosch: Lineare Algebra

	Brieskorn: Lineare Algebra und Analytische Geometrie Bröcker: Lineare Algebra und Analytische Geometrie Fischer: Lineare Algebra Greub: Linear Algebra (auch deutsch) Koecher: Lineare Algebra und Analytische Geometrie
10	Comment recommended: Mathematics: Bachelor year 1

Mod	lule nam	ne								
	Linea	r Algeb	ra II							
Module no. 04-10- 0005/de		Points 9 CP	Workload Self- 270 h		-study Duration		•		ncy . semester	
Lang Gerr	guage of man	Instruct	ion			on responsib . Dr. rer. nat.			ule	
1	Courses	s of the	Module							
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	008-tt	Linear A	lgebra II	0	Convention		1		
	04-00-00	008-vu	Linear A	lgebra II	0	0 Lecture Exercis			6	
2	an mini and uni possible	s of linea mal poly tary spa	nomials ces; bilin ons: affi	ons; eigenvalues an in the ring of univa lear forms, quadrati ne and projective ge	riate c fori	polynomials; ms, quadrics;	Jordan n	ormal	form; euo	clidean
3	 Learning Outcomes Students are familiar with central concepts and techniques of linear algebra. They have acquired an understanding of the relevant abstract algebraic notions and can apply them in other areas of mathematics as well as relate them to underlying geometric concepts. 									
4	•		or Parti o Linear A	•						
5		f Examir odule Ex	nation aminatio	on:						

	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik
9	Literature Bosch: Lineare Algebra Brieskorn: Lineare Algebra und Analytische Geometrie Bröcker: Lineare Algebra und Analytische Geometrie Fischer: Lineare Algebra Greub: Linear Algebra (auch deutsch) Koecher: Lineare Algebra und Analytische Geometrie
10	Comment recommended: Mathematics: Bachelor year 1

Module name

Linear Algebra II

Module no.Credit PointsWorkload04-10-9 CP270							study 165 h	Duration 1 Semest		Freque Every 2	ency 2. semester
Lang Engli	-	Instruct	ion				o <mark>n responsik</mark> Dr. rer. nat.			ıle	
1		s of the	Module			1101.					
	Course	no.	Course	name			Workload (CP)	Form Teach		Contact Hours per Week
	04-00-00 04-00-00		Linear A Linear A				0		Conver Lecture Exercis	e and	1 6
2	an mini and uni	s of linea mal poly tary spa	nomials ces; bilin	in the ring of ear forms, of	of univa quadrati	riate p ic form	gonalisation polynomials; ns, quadrics; or elements	Jordan no possible e	ormal f excursi	form; eu ions: af	uclidean
3	Student an unde of math	erstandii nematics	miliar wi ng of the as well a	relevant ab as relate the	stract a	lgebra	echniques of aic notions a ing geometri	nd can ap	ply the	-	ive acquired her areas
4	-		or Partio Linear A	-							
5		Module	kaminatio e Examin e Examin	ation (Study			n, Special For tion, oral / w				
	small n exam. T	umber o The decis the first	f potenti sion abou	al participa ut the form	nts. In tl of the e	his cas xam is	f a written te se, the exam s taken and c n the prospe	can be ta communic	ken in ated	the for	m of an oral
	of the h	iomewo	rk assign	ments. The	precise	propo	ent successf ortion of nec structor durin	essary ass	ignme	nts and	
6	-		on the Av	ward of Cre	dit Poin	ts					

7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, LaG Mathematik
9	Literature
	Bosch: Lineare Algebra
	Brieskorn: Lineare Algebra und Analytische Geometrie
	Bröcker: Lineare Algebra und Analytische Geometrie
	Fischer: Lineare Algebra
	Greub: Linear Algebra (auch deutsch)
	Koecher: Lineare Algebra und Analytische Geometrie
10	Comment
	recommended: Mathematics: Bachelor year 1

Мос	lule nam	ne									
	Linea	nr Algeb	ora								
Module no. 04-10- 0006/de		Points 18 CP	Workload	540 h		study 300 h	Duration 2 Semester		Frequency Every semester		
Lang Gerr	guage of man	Instruct	ion				on responsib Dr. rer. nat.				
1	Courses of the Module										
	Course no. Course			e name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	008-tt	Linear A	gebra II			0		Conver	ntion	2
	04-00-0008-vu Linear A		Linear A	lgebra II			0		Lecture Exercis		6
	04-00-0	042-tt	Linear A	r Algebra I			0		Convention		2
	04-00-0042-vu Linear A		Linear A	Igebra I			0		Lecture and Exercise		6

2	Study Content
	Part 1: basic notions and concepts, algebraic structures (groups, rings, fields);
	vector spaces, linear dependence, bases, dimension; linear and affine subspaces,
	products, sums and quotients, dual space; linear maps and matrices; determinants;
	Part 2: systems of linear equations; eigenvalues and diagonalisation of endomorphisms; characteristic an minimal polynomials in the ring of univariate polynomials; Jordan normal form; euclidean and unitary spaces; bilinear forms, quadratic forms, quadrics; possible excursions: affine and projective geometry, geometry of conic sections, or elements of multilinear algebra
3	Learning Outcomes
	Die Studierenden können die Konzepte der linearen Algebra in verschiedenen
	Zusammenhängen erkennen, anwenden und erklären. Sie lernen insbesondere,
	abstrakt-axiomatisch Begriffsbildungen der linearen Algebra auf einschlägige
	Probleme anzuwenden, mit geometrischen Begriffen in Verbindung zu bringen,
	typische Aufgaben zu lösen und einfache Beweise zu führen.
4	Requirements for Participation
	keine
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, Technical Examination, Weight: 100%,
	Standard)
	Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not
	Passed)
8	Usability of the Module
	Grundstudium Mathematik
9	Literature
	Bosch: Lineare Algebra
	Brieskorn: Lineare Algebra und Analytische Geometrie
	Bröcker: Lineare Algebra und Analytische Geometrie Fischer: Lineare Algebra
	Greub: Linear Algebra (auch deutsch)

	Koecher: Lineare Algebra und Analytische Geometrie
10	Comment

	Linea	ar Algeb	ra						
Module no.		Credit P		Workload 540 h	Self-study 300 h	Duration 2 Semest		Frequency Every 2. semeste	
	guage of lish	Instruct	ion		Person responsib Prof. Dr. rer. nat.				
1	Course	s of the I	Module						
	Course	no.	Course	name	Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	012-tt	Linear A	gebra II	0		Conven	ntion	2
	04-00-0	012-vu	Linear A	gebra II	0		Lecture and Exercise		6
	04-00-0041-tt		Linear A	gebra I	0		Conven	ntion	2
	04-00-0041-vu		Linear Algebra I		0		Lecture and Exercise		6
	vector s produc Part 2: charact form; e excursi	spaces, li ts, sums systems eristic an uclidean	inear dep and quo of linear n minima and uni ne and p	d concepts, algebrai bendence, bases, di tients, dual space; l equations; eigenva al polynomials in the tary spaces; bilinea rojective geometry,	mension; linear an inear maps and ma lues and diagonali e ring of univariate r forms, quadratic	d affine s atrices; de sation of polynom forms, qu	ubspac etermir endom nials; Jo nadrics;	nants; orphism ordan no possible	rmal
3	Learning Outcomes Students will be able to recognise the concepts of linear algebra in various contexts, and to apply and explain them. In particular, they will have learnt to apply abstract-axiomatic notions of linear algebra to typical problems, to connect them with geometric concepts, to solve typical problems and to conduct simple proofs.								

	keine
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) Module Examination (Study Examination, Study Examination, Passed / Not Passed) Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Grundstudium Mathematik
9	Literature Bosch: Lineare Algebra Brieskorn: Lineare Algebra und Analytische Geometrie Bröcker: Lineare Algebra und Analytische Geometrie Fischer: Lineare Algebra Greub: Linear Algebra (auch deutsch) Koecher: Lineare Algebra und Analytische Geometrie
10	Comment

Modu	Module name								
	Introduction to Mathematical Software								
Modu 04-10- 0009/	-	Credit Points 3 CP	Workload 90 h	Self-study 60 h	Duration 1 Semester	Frequency Every 2. semester			
Langu Englisl	-	Instruction		Person responsible for the Module					
1 C	Courses	s of the Module							

-	1			1	1						
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-00-0045-vl	Introduction to Mathematical Software	0	Lecture	2						
2	Study Content										
	Software support mathematical pr arithmetic and numerical comp	Contents of Linear Algebra 1 and Analysis 1 are incorporated. Software supported symbolic and numerical solution of elementary and basic mathematical problems. For instance, Mathematica or Maple: matrix arithmetic and systems of linear equations, difference between symbolic and numerical computation, differentiation and integration; limits and series; graphics and and visualisation; definition of functions and programming.									
3	Learning Outco	omes									
		erende das Modul besucht haber		ens							
	0	es mathematisches Softwarepak hematische Sachverhalte algorith									
	o emiache mati	nematische Sachverhalte algorith	imisch umsetzen.								
4	Requirements	for Participation									
	keine										
5	Form of Examir	nation									
	Final Module Ex	kamination:									
	• Modul	e Examination (Study Examinatio	n, Study Examination,	Passed / Not P	assed)						
	Verantwortlich	: AG Optimierung									
6	Requirements	on the Award of Credit Points									
7	Grading										
-	Final Module Ex	kamination:									
	Modul	e Examination (Study Examinatio	n Study Examination	Weight: 100%	Passed /						
	Not Pas				, assea y						
8	Usability of the	Module									
	Für B.Sc.Math,	B.Sc.Math (bilingual), B.Sc.WiMa,	, B.Sc.MCS, B.Sc.ME: P	flicht							
9	Literature										
	David Withoff:										
	withoff#47;inde	47;#47;library.wolfram.com#47; ex2.html	comerences#47;devco	<u>n199#47;</u>							
	MapleSoft Appl	lication Center,									
		47;www.maplesoft.com#47;appli	cations#47;[/url]								

Мо	dule nam	ne								
	Intro	duction	to scie	ntific programmin	g					
Module no. 04-10- 0010/de		Credit F	Points 3 CP	Workload 90 h	Self-	study 45 h	Duratio 1 Semes		Frequency Every 2. semester	
Language of Instruction German					Pers	on responsib	le for the	e Modu	le	
1	Course	s of the	Module							
	Course no.		Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	009-ku	Introduc program	tion to scientific ming		0		Course	2	3
3	standard functions, vector operations, boolean operations, control flow statements, input, output, subroutines, graphics. Learning Outcomes Die Studierenden können grundlegende Techniken des wissenschaftlichtechnischen Programmierens anhand einer Programmiersprache wiedergeben und beschreiben und durch sicheren und vertrauten Umgang mit der Sprache zur Umsetzung vorgelegter numerischer									
	-			Sie sollen Algorithr te Problemstellung						
4	Require	ements f	or Partio	ipation						
5	Form of Examination Final Module Examination: • Module Examination (Study Examination, Study Examination, Passed / Not Passed)									
6	Require	ements o	on the A	ward of Credit Poin	ts					
7	Grading	3								

	 Final Module Examination: Module Examination (Study Examination, Study Examination, Weight: 100%, Passed / Not Passed)
8	Usability of the Module Pflichtmodul
9	Literature Matlab User Guide
10	Comment Verantwortlich: AG Optimierung

Mo	dule nan	ne										
	Ordi	nary Dif	ferentia	l Equations					1			
Module no. 04-10- 0011/de		Credit Points		Workload		study	Duration	-	Frequency			
			5 CP	150 h		105 h	1 Semes	ter	Every 2. semest			
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ule			
Ger	man				Prof	. Dr. rer. nat.	Matthias	Hiebe	r			
1	Course	Courses of the Module										
	Course			name	ame		Workload (CP)		Form of Teaching			
	04-00-0	054-vu	Ordinary	Differential Equation	IS	0	Lecture and Exercise		3			
2	-	tion of va s of first		Theorems of Picard her order, variation				-		•		
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of the theory of ordinary differential equations - are able to recognise the treated concepts in various fields of mathematics.											
4	-		or Parti o Analysis	Sipation and Linear Algebra								

5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, LaG Mathematik, B.Sc. Physik
	M.Sc. ETIT
9	Literature
	H. Amann: Gewöhnliche Differentialgleichungen, de Gruyter W. Walther: gew. DGL, Springer
10	Comment
	recommended: Mathematics: Bachelor year 2, Teaching Degrees

Module name

Complex Analysis

_]
	lule no. Credit P		^{10.} Credit Points Workload		Self-s	tudy		Duration		Frequency		
	04-10- 5 CP 150 h				-	105 h	1 Semes	ter	Every 2	2. semester		
	-									• • •		
_	-	Instruct	ion					-	le for the			
German Prof. Dr. rer. nat. Matthias Hieber												
1	Courses	s of the l	Module							1		
	Course	no.	Course	name	e		Workload (CP)		CP)	Form of Teaching		Contact Hours per Week
	04-00-02	225-vu	Complex	Analysis			D			Lecture Exercis		3
2	analytic Laurent	-Rieman tity, Liou series a	ville's Th nd isolat	ntial equati neorem and ted singulari	Fundam	nental	Theor	rem of				nd Formula; ber;
	Learning Outcomes Students- understand and are able to apply the notions, methods and results treated in the course- develop a Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of Complex Analysis - are able to recognise the treated concepts in various fields of mathematics.basic level of understanding of the Complex Analysis - are able to recognise the treated concepts in various fields of mathematics.											
4	-		or Partic Analysis	and Linear	Algebra							
5		f Examir odule Ex	ation aminatio	on:								
	•	Module min, Sta		ation (Tech	nical Exa	amina	tion, c	oral / w	vritten Exa	aminat	ion, Du	ration 60
	•	Module	e Examin	ation (Study	y Examii	nation	, Spec	ial For	m, Passe	d / No	t Passed	(b
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, exce when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.								can be and			
6	Passing	the Fac	hprüfung	ward of Cre g; ung is a prei			aking t	the Fac	chprüfung	5		

7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik
9	Literature Freitag: Funktionentheorie I, Springer Remmert: Funktionentheorie I Conway: Functions of one complex variable, Springer
10	Comment recommended: Mathematics: Bachelor year 2, Teaching Degrees

Мос	lule nan	ne								
	Intro	duction	to Nun	nerical Analysis						
04-1	Module no. 04-10- 0013/de Credit Points 9 CP		Workload 270 ł		study 180 h	Duration 1 Semester		Frequency Every 2. semester		
Lang Gerr	-	Instruct	ion			on responsib . Dr. rer. nat.			ule	
1	Course	s of the l	Module							
	Course no. Course name		name		Workload ((CP)	Form Teach	••	Contact Hours per Week	
	04-00-0	056-vu	Introduc	ction to Numerical Ai	nalysis	0		Lectur Exercis		6
2	error ai linear a least so interpo integra	nd nonli Juares pr	oblems nd appro differen	tems of equations ximation tiation						

3	Learning Outcomes
	The students are able to describe, explain and apply basic elememtary numerical methods. They should have the ability to compare, modify and combine them.
4	Requirements for Participation recommended: Analysis and Linear Algebra, Introduction to Scientific Programming
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, LaG Mathematik
	M.Sc. ETIT
9	Literature Deuflhard, Hohmann: Numerical Analysis in Modern Scientific Computing: An Introduction; Texts in Applied Mathematics 43, Springer 2003. Stoer, Bulirsch: Introduction to Numerical Analysis; Texts in Applied Mathematics 12, Springer 2002 Matlab User Guide

-	10	Comment
		recommended: Mathematics: Bachelor year 2, Teaching Degrees

Мо	dule nam	ne									
	Worl	king skil	ls in ma	thematics				1			
04-1	Module no. 04-10- 0014/de		oints 2 CP	Workload 60 h	Self-study Duration 60 h 1 Semes					-	
	guage of man	Instruct	ion			•		le for the des Fach			
1	Courses of the N Course no.		Module Course name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0	146-ku	Working	skills in mathematics		0			Course	2	0
3	techniq exampl Learnin Nach de Schreib	ues for t es, feed g Outco em Besu -und Arb	he prese back and mes ch des M peitstech	texts, mathematica entation of mathem d discussion. Noduls können die S niken nutzen sowie matischen Sachverh	atical tudier Präse	materia	fachs	pezifiche	und gr	rundleg	
4	-	ements f s und Lin		•							
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Study Examination, Passed / Not Passed) 										
6	Require	ements o	on the A	ward of Credit Poin	ts						
7	Gradin Final M	g odule Ex	aminatio	on:							

	 Module Examination (Study Examination, Study Examination, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik, Wahlpflichtbereich Ü
9	Literature
	Beutelspacher: Das ist oBdA trivial! Vieweg
	Bünting, Bitterlich, Pospiech: Schreiben im Studium: ein Trainingsprogramm Cornelsen Doob et
	al.: A manual for authors of mathematical papers, AMS
	Higham: Handbook of Writing for the Mathematical Scienes, SIAM
	Kämer: Wie schreibe ich eine Seminar-oder Examensarbeit?
	Fischer van Gasteren: On the shape of mathematical arguments, Springer
10	Comment
	Verantwortlich: Studiendekan

Mod	lule nam	ne									
	Integ	gration 1	Theory								
Module no. 04-10- 0015/de		Points 9 CP	Workload 2	270 h	Self-	tudy Duration 180 h 1 Semes			Frequency Every 2. semester		
Language of InstructionPerson responsible for the ModuleGermanProf. Dr. rer. nat. Moritz Egert											
1	Course	s of the	Module								
	Course no. Course		Course	name	ame		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	015-vu	Integrat	on Theory			0	Lecture Exercis	0 00	6	
2	Study Content Part I: sigma-algebras, measures, outer measures and Carathéodory's theorem, Lebesgue measure; measurable functions, Lebesgue integral, convergence theorems, Lp-spaces, Fubini's theorem in R^n change of variables formula. Part II: Convolution integrals, Fouriertransform; Submanifolds, surface measures, divergence theorem, Green's theorem, Stokes' theorem.										
3	After p		ion in thi	s module stud of measures, co				otion of i	ntegra	tion and	compare

	it with the classical Riemann integral,
	- choose and apply suitable theorems of convergence,
	- extend notions from measure and integration theory to submanifolds and apply integral
	theorems of vector calculus
4	Requirements for Participation
	recommended: Analysis and Linear Algebra
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination. Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, LaG Mathematik
9	Literature
	J. Elstrodt: Mass-und Integrationstheorie, Springer
	O. Forster: Analysis 3, Vieweg
	S. Lang: Real Analysis, Addison-Wesley
	H.Amann, J.Escher: Analysis III, Birkhäuser
L	

10	Comment
	recommended: Mathematics: Bachelor year 2, Teaching Degrees

	Integ	ration	Theory I									
04-	dule no.	e no. Credit Points Workload			Self-study 30	Self-study Duration 30 h 1 Semes			ncy . semester			
	guage of man	Instruct	ion		Person respons Prof. Dr. rer. nat			ıle				
1	Courses of the Module											
	Course	no.	Course	name	Workload	(CP)	Form of Teaching		Contact Hours per Week			
	04-00-0	013-vu	Integrati	on Theory I	0		Lecture Exercis		6			
	theorer	ns, Lp sp	aces, Fu	bini's theorem, cha	nge of variable fo	rmula and	ence I applic	ations.				
3	Learnin	g Outco	mes	bini's theorem, cha 10duls können die S		rmula and		cations.				
3	Learnin Nach de - die He	g Outco em Besu erleitung	mes ch des M von Mal		tudierenden einen verallgeme		l applic		fbauen			
3	Learnin Nach do - die He sowie n	g Outco em Besu erleitung nit dem	mes ch des M von Mal klassisch	1oduls können die S ßen skizzieren und e	tudierenden einen verallgeme al vergleichen	nerten Int	l applic		fbauen			
	Learnin Nach de - die He sowie n - in Anv Require	g Outco em Besu erleitung nit dem vendung ements f	mes ch des M von Mal klassisch	loduls können die S ßen skizzieren und e en Riemann-Integra gnete Konvergenzsä c ipation	tudierenden einen verallgeme al vergleichen	nerten Int	l applic		fbauen			
4	Learnin Nach de - die He sowie n - in Anv Require Analysis	g Outco em Besu erleitung nit dem vendung ements f s und Lir f Examir	mes ch des M von Mal klassisch en geeig or Partic heare Alg	loduls können die S ßen skizzieren und e en Riemann-Integra mete Konvergenzsä Sipation gebra	tudierenden einen verallgeme al vergleichen	nerten Int	l applic		fbauen			
3 4 5	Learnin Nach de - die He sowie n - in Anv Require Analysis	g Outco em Besu erleitung nit dem vendung ements f s und Lir f Examir odule Ex Module	mes ch des M von Mal klassisch en geeig or Partic heare Alg hation kaminatic e Examin	loduls können die S ßen skizzieren und e en Riemann-Integra mete Konvergenzsä Sipation gebra	tudierenden einen verallgeme al vergleichen tze auswählen ur	nerten Int d erklärer mination,	egralb	egriff au d / Not P	assed)			

7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module Für B.Sc.WiMa, B.Sc.Mamp;E: Pflicht Für M.Ed.Math, LaG.Math: als mathematische Ergänzung Für B.Sc.Phys: als nichtphys. Ergänzungsfach
9	Literature J. Elstrodt: Mass-und Integrationstheorie, Springer S. Lang: Real Analysis, Addison-Wesley H.Amann, J.Escher: Analysis III, Birkhäuser
10	Comment Verantwortlich: NF Farwig (ana)

	Integ	ration	Theory I	I							
04-2	dule no. 10- 7/de	Credit I	Points 5 CP	Workload	150 h	Self-stuc	•	Duration 1 Semest		reque i very 2	1cy . semester
	guage of man	Instruct	tion				-	le for the Moritz Eg		9	
1	Courses of the Module										
	Course no. Course name					Wo	orkload ((CP)	Form of Teachin		Contact Hours per Week
	04-00-0	143-vu	Integrat	on Theory II		0			Lecture a Exercise	ind	6
2		ution int	-	ouriertransfo een's theore				e measur	es,		

3	Learning Outcomes							
	Nach dem Besuch des Moduls können die Studierenden							
	- Maß- und Integrationsbegriffe auf Untermannigfaltigkeiten							
	erweitern und im Kontext von Integralsätzen kombinieren							
4	Requirements for Participation							
	Analysis, Lineare Algebra und Integrationstheorie I (Wima)							
5	Form of Examination							
	Final Module Examination:							
	• Module Examination (Technical Examination, Technical Examination, Standard)							
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)							
6	Requirements on the Award of Credit Points							
7	Grading							
ľ	Final Module Examination:							
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) 							
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed) 							
8	Usability of the Module							
	Für B.Sc.WiMa, B.Sc.ME: math. Wahlbereich							
9	Literature							
	O. Forster: Analysis 3, Vieweg; S. Lang: Real Analysis, Addison-Wesley; H. Amann, J. Escher: Analysis III, Birkhäußer							
10	Comment Verantwortlich: NF Farwig (ana)							

Module nam	Module name									
Introduction to Algebra										
Module no. 04-10-	Credit Points 5 CP	Workload	50 h	Self-study	Duration 1 Semester	Frequency Every 2. semester				
0018/de Language of				Person responsib		,				

Ger	man		Prof	. Dr. rer. nat. Jan H	endrik Bruinier				
1	Courses of the Module								
	Course no.	Course name		Workload (CP)	Form of Teaching	Contact Hours per Week			
	04-00-0006-vu	Introduction to Algebra		0	Lecture and Exercise	3			
2	Study Content Elementary gro	up theory, group actions, rir	ngs, d	ivisibility, polynom	ial rings, modules	5.			
3		mes stand the basic notions and o apply those to typical prob			f groups, rings ar	nd modules.			
4	Requirements f recommended:	for Participation Linear Algebra							
	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Module Examination (Study Examination, Special Form, Passed / Not Passed) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 								
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.								
6	Passing the Fac	on the Award of Credit Poin hprüfung; dienleistung is a prerequisite		taking the Fachprüf	ung				
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 								

	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik
9	Literature S. Lang: Algebra, Addison-Wesley; N. Jacobson: Basic Algebra 1, Freeman S. Bosch: Algebra, Springer
10	Comment recommended: Mathematics: Bachelor year 2

Мо	dule nan	ne									
	Intro	duction	to Sto	chastics						-	
Module no. 04-10- 0019/de		Credit Points Work 9 CP		Norkload S 270 h		study 180 h	Duration 1 Semester		Frequency Every 2. semeste		
Language of Instruction					Pers	on responsib	le for the	e Modu	ule		
Ger	man					Prof.	Dr. rer. nat.	Michael	Kohler		
1	Course	Courses of the Module									
	Course no.		Course	Course name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0004-vu li		Introduction to Stochastics				0		Lecture and Exercise		6
2	Study Content Probability spaces and random variables, distribution functions, expectation and variance, independence and elementary conditional expectations, discrete and absolutely continuous distributions, Law of Large Numbers, Central Limit Theorem, estimation and confidence intervals, testing under the hypothesis of normality. Application and analysis of selected basic models of probability theory. Possible societal implications will be addressed in the lecture.										
3	Learning Outcomes The students will -be able to describe the most important ide on simple models. -know some of the most important method										

r	
	models.
	-be able to transfer these methods to similar problems.
	Students are able to contextualize subject matter within the social context, critically assess the
	consequences, and act ethically and responsibly accordingly.
4	Requirements for Participation
	recommended: Analysis and Linear Algebra
5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung;
	Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik, LaG Mathematik, M. Ed. Mathematik
	M.Sc. ETIT
9	Literature
1	Eckle-Kohler, Kohler: Eine Einführung in die Statistik und ihre Anwendungen;
	Irle: Wahrscheinlichkeitstheorie und Statistik; Krengel: Einführung in dieWahrscheinlichkeitstheorie und Statistik;

	Georgii: Stochastik: Einführung in die Wahrscheinlichkeitstheorie und Statistik;
10	Comment recommended: Mathematics: Bachelor year 2, Teaching Degrees

Мо	dule nan	ne								
	Algo	rithmic	Discrete	e Mathematics	-					
Module no. 04-10- 0020/de		Points 5 CP	Workload 150 h	Self	study 105 h	Duration 1 Semester		Frequency Every 2. semeste		
Language of Instruction German						on responsib . Dr. Yann Dis		e Mod	ule	
1	Course	s of the	Module							
	Course	Course no.		ourse name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0005-vu Algori			hmic Discrete Mathematics		0		Lecture and Exercise		3
completeness, searching and sorting. Possible additional topics: coding/cryptography, more graph algorithms, e.g., mir					min-co	st flows				
3	Learning Outcomes After attending this course, students will know basic discrete structures, will understand the algorithmic viewpoint on the example of problems from different parts of mathematics.									
4	Requirements for Participation recommended: Analysis, Linear Algebra									
5	Form of Examination Final Module Examination:									
	 Module Examination (Technical Examination, oral / written Examination, Duratio min, Standard) 							ration 60		
	Module Examination (Study Examination, Special Form, Passed / Not Passed)									

	Fachprüfung: In der Regel erfolgt die Prüfung durch eine Klausur, bei geringer Teilnehmerzahl								
	gegebenenfalls mündlich. Die Form der Prüfung wird anhand der voraussichtlichen								
	Teilnehmerzahl in den ersten beiden Veranstaltungswochen festgelegt.								
6	Requirements on the Award of Credit Points								
	Passing the Fachprüfung;								
	Passing the Studienleistung is a prerequisite for taking the Fachprüfung								
7	Grading								
	Final Module Examination:								
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 								
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) 								
8	Usability of the Module								
	B.Sc. Mathematik, LaG Mathematik								
9	Literature								
	M. Aigner, Diskrete Mathematik, 5. Auflage, Vieweg, 2003.								
	T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein: Introduction to algorithms, 2. Auflage, BT, 2001.								
	B. Korte, J. Vygen: Combinatorial Optimization, Springer 2012.								
	J. Matoušek, J. Nešetril, Diskrete Mathematik. Eine Entdeckungsreise, Springer, 2002.								
10	Comment								
	recommended: Mathematics: Bachelor year 2, Teaching Degrees								

Мо	dule nan	ne									
	Algo	rithmic	Discrete	e Mathemat	tics						
Module no. 04-10- 0020/en		Credit I	Points 5 CP	Workload P 150 ł			study 105 h	Duration 1 Semester		Frequency Every 2. semester	
					Person responsible for the Module Prof. Dr. Yann Disser						
1	Courses of the Module										
	Course no. Course		name			Workload ((CP)	Form Teacl	••	Contact Hours per Week	
	04-00-0	005-vu	Algorith	mic Discrete N	lathem	atics	0		Lectur	e and	3

	Exercise									
2	Study Content									
	Graph theory, growth of functions and asymptotic analysis of complexity, algorithms for spanning trees, shortest paths, matchings in bipartite graphs and flows in directed graphs, NP-completeness, searching and sorting.									
	Possible additional topics: coding/cryptography, more graph algorithms, e.g., min-cost flows									
3	Learning Outcomes									
After attending this course, students will know basic discrete structures, will understand t algorithmic viewpoint on the example of problems from different parts of mathematics.										
4	Requirements for Participation recommended: Analysis, Linear Algebra									
5	Form of Examination Final Module Examination:									
	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)									
	Module Examination (Study Examination, Special Form, Passed / Not Passed)									
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.									
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.									
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung									
7	Grading Final Module Examination:									
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 									
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) 									
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik									

9	Literature								
	M. Aigner, Diskrete Mathematik, 5. Auflage, Vieweg, 2003. T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein: Introduction to algorithms, 2. Auflage, BT, 2001.								
	B. Korte, J. Vygen: Combinatorial Optimization, Springer 2012. J. Matoušek, J. Nešetril, Diskrete Mathematik. Eine Entdeckungsreise, Springer, 2002.								
10	Comment								
	recommended: Mathematics: Bachelor year 2, Teaching Degrees								

	dule nam Logic	and Fo	undatio	ons						
Module no. 04-10- 0021/de				Workload 90 h		- study 60 h	Duration 1 Semes		Frequency Every 2. semeste	
	guage of man	Instruct	ion			son responsib f. Dr. rer. nat.			ule	
1	Course Course	s of the I no.	Module Course	name		Workload ((CP)	Form Teacl		Contact Hours per Week
	04-00-0144-vu Logic an			d Foundations	oundations		0		e	2
	Elementary logic: propositional logic and first order logic; syntax, semantics and deductive calculi. Basic axiomatic set theory; set-theoretic construction of basic mathematical entities; ordinal and cardinal numbers. Computability, decidability and recursive enumerability based on a simple model of computation.									
3	Learning Outcomes									
	Die Studierenden verstehen einfache Formalisierungen mathematischer Aussagen in formalen Systemen und können auf elementarem Niveau mit Beweisen in einem formalen System umgehen.									
	Sie können exemplarisch die Modellierung allgemeiner mathematischer Begriffsbildungen, Konstruktionen und Beweise im Rahmen der Mengenlehre nachvollziehen. Sie kennen die									
	Bedeutung der fundamentalen Konzepte aus klassischer Logik und Berechenbarkeitstheorie für Grundlagenfragen der Mathematik. Nach dem erfolgreichen Besuch der Veranstaltung können die Studierenden z.B. zu Fragen der folgenden Art informiert Stellung nehmen: "Was ist eine									
						-				-

	mathematische Erkenntnis sicher?", "Kann man jede wahre mathematische Aussage beweisen?"
4	Requirements for Participation
	allgemeines mathematisches Grundwissen aus dem 1. Fachsemester
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Study Examination, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik, Wahlpflichtbereich Ü
9	Literature
	(Exemplarisch) Forster, T.: Logic, Induction and Sets. CUP, 234pp., 2003
	Kay, R.: The Mathematics of Logic. CUP, 204pp., 2007
	Schindler, R.: Logische Grundlagen der Mathematik. Springer, 203pp., 2009.
10	Comment
1	

Мос	dule nan	ne									
	Logic	and Fo	undatio	ons							
Module no. 04-10- 0021/en		Credit F	Points 3 CP	Workload 90 h		Self-study		Duration 1 Semester		Frequency Every 2. semester	
Language of Instruction English					Person responsible for the Module Prof. Dr. rer. nat. Martin Otto						
1	Course	s of the l	Module								
	Course no. Course		name		Worl	kload ((CP) Form Teac		••	Contact Hours per Week	
	04-00-0	145-vl	Logic and	d Foundations		0			Lectur	е	2

2	Study Content
	Elementary logic: propositional logic and first order logic; syntax, semantics
	and deductive calculi. Basic axiomatic set theory; set-theoretic construction
	of basic mathematical entities; ordinal and cardinal numbers. Computability,
	decidability and recursive enumerability based on a simple model of
	computation.
3	Learning Outcomes
	Die Studierenden verstehen einfache Formalisierungen mathematischer Aussagen in formalen
	Systemen und können auf elementarem Niveau mit Beweisen in einem formalen System
	umgehen.
	Sie können exemplarisch die Modellierung allgemeiner mathematischer Begriffsbildungen,
	Konstruktionen und Beweise im Rahmen der Mengenlehre nachvollziehen. Sie kennen die
	Bedeutung der fundamentalen Konzepte aus klassischer Logik und Berechenbarkeitstheorie für
	Grundlagenfragen der Mathematik. Nach dem erfolgreichen Besuch der Veranstaltung können
	die Studierenden z.B. zu Fragen der folgenden Art informiert Stellung nehmen: "Was ist eine
	wahre Aussage?", "Was ist ein Beweis?", "Wo liegt der Unterschied zwischen Mengen und
	Klassen?", "Wie misst man verschiedene Grade der Unendlichkeit?", "In welchem Sinne ist
	mathematische Erkenntnis sicher?", "Kann man jede wahre mathematische Aussage beweisen?"
4	Requirements for Participation
	allgemeines mathematisches Grundwissen aus dem 1. Fachsemester
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading
1	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Weight: 100%, Passed /
	Not Passed)
-	
8	Usability of the Module
	Wahlpflicht Ü-Bereich.
9	Literature
	(Exemplarisch)
	Forster, T.: Logic, Induction and Sets. CUP, 234pp., 2003
	Kay, R.: The Mathematics of Logic. CUP, 204pp., 2007
	Schindler, R.: Logische Grundlagen der Mathematik. Springer, 203pp., 2009.
	semmer, in Eoglatic and independent wer muticinatik apriliger, 200pp, 2005.

10	Comment

	Math	ematic	s in Con	text (Lehramt)	T				n	
Module no. Credit Points Workload 04-10- 5 CP 150 k					Self-s	study	Duration	า	Freque	ency
-	10- 2/de		5 CP	150 h		-	1 Semes	ter	-	4. semester
	guage of man	Instruct	ion			on responsib Dr. rer. nat.				
1	Course	s of the l	Module		4					
	Course	no.	Course	name		Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-00-0	186-vu	Mathem Lehramt	atik im Kontext (für)		0		Lecture and Exercise		3
	 -Numbers from antiquity to modern timer; -Irrational numbers, Fibonacci numbers, continued fractions; -Infinity from Zenon to Cantor; -Infinitely small quantities, measure theory, and non-standart analysis; -School mathematics versus university. 									
 School mathematics versus university. 3 Learning Outcomes Die Studierenden sind in der Lage, anhand konkreter mathematischer Inhalte Mathematik ihren Wechselwirkungen zu Kultur und Gesellschaft zu beschreiben, die Rolle der Mathem ihren verschiedenen Kontexten zu beurteilen und mit ihrem Hintergrundwissen den Schulunterricht zu bereichern. Sie sind in der Lage, das Fach Mathematik in Schule und Öffentlichkeit angemessen zu vertreten 										

10	Comment							
	 P. J. Davies, R. Hersh: Erfahrung Mathematik. Birkhäuser, 1994. M. Kline: Mathematical Thought from Ancient to Modern Times. Oxford University Press, 1972. H. Wußing: 6000 Jahre Mathematik. Springer, 2008. 							
	C. C. Gillispie: Dictionary of Scientific Biography. Charles Scribner's Sons, 1970 - 1991.							
	C. Boyer: A History of Mathematics. John Wiley, 1968ff.							
9	Literature Victor Katz: A History of Mathematics. Harper Collins, 1993.							
8	Usability of the Module Mathematische Ergänzung							
	 Module Examination (Study Examination, Homework, Worksheets, Weight: 0%, Passed / Not Passed) 							
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 							
5	Requirements on the Award of Credit Points Passing the "Fachprüfung" (Technical Examination)							
	Studienleistung: In der Regel erfolgreiche Bearbeitung eines Teils der Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.							
	Fachprüfung: In der Regel erfolgt die Prüfung durch eine Klausur, bei geringer Teilnehmerzahl gegebenenfalls mündlich. Die Form der Prüfung wird anhand der voraussichtlichen Teilnehmerzahl in den ersten beiden Veranstaltungswochen festgelegt.							
	 Module Examination (Fedmical Examination, orally written Examination, Standard) Module Examination (Study Examination, Homework, Worksheets, Passed / Not Passed) 							
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) 							

	Math	nematic	s in Cor	text									
Module no. 04-10- 0023/de		Credit F	Points 3 CP	Workload 90 h	Self-study 60 h	Duration 1 Semester	Frequ Every	ency 2. semester					
Language of Instruction German					Person responsib	le for the Mo	dule						
1		s of the	Module										
	Course	no.	Course	name	Workload ((-	m of ching	Contact Hours per Week					
	04-00-0	016-vl	Mathem	atics in Context	0	Lect	ure	2					
	-Irration -Infinity -Infinite -School	 -Outline of the history of mathematics; -Numbers from antiquity to modern times; -Irrational numbers, Fibonacci numbers, continued fractions; -Infinity from Zenon to Cantor; -Infinitely small quantities, measure theory, and non-standard analysis; -School mathematics versus university mathematics 											
3	Learning Outcomes Die Studierenden sind in der Lage, anhand konkreter mathematischer Inhalte Mathematik in ihren Wechselwirkungen zu Kultur und Gesellschaft zu beschreiben, die Rolle der Mathematik in ihren verschiedenen Kontexten zu beurteilen und das Fach Mathematik in Beruf und Öffentlichkeit angemessen zu vertreten.												
4	-	ements f s und Lir		•									
5		-		on:			Analysis und Lineare Algebra 5 Form of Examination Final Module Examination:						

Module Examination (Study Examination, Study Examination, Passed / Not Passed)
Requirements on the Award of Credit Points
Bestehen der Studienleistung
Grading
Final Module Examination:
Module Examination (Study Examination, Study Examination, Weight: 100%, Passed /
Not Passed)
Usability of the Module
B.Sc. Mathematik (PO 2011), Wahlpflichtbereich Ü
Literature
Victor Katz: A History of Mathematics. Harper Collins, 1993.
C. Boyer: A History of Mathematics. John Wiley, 1968ff.
C. C. Gillispie: Dictionary of Scientific Biography. Charles Scribner's Sons, 1970 - 1991.
P. J. Davies, R. Hersh: Erfahrung Mathematik. Birkhäuser, 1994.
M. Kline: Mathematical Thought from Ancient to Modern Times. Oxford University Press, 1972.
H. Wußing: 6000 Jahre Mathematik. Springer, 2008.
Comment
Verantwortlich: NF Kümmerer

Мо	dule nan	ne									
	Logic	and Fo	oundatio	ons							
Module no. 04-10-		Credit Points				Self-study		Duration		Frequency	
002	24/de	5 CP			150 h		105 11	1 Semest	.er	Every	4. semester
Lan	guage of	Instruct	tion			Persor	n responsib	le for the	Modu	ıle	
Ger	man					Prof. D	Dr. phil. nat	. Ulrich Ko	hlenb	ach	
1	Courses of the Module										
	Course	no.	o. Course name		V	Vorkload ((CP) Forn Teac		•••	Contact Hours per Week	

	04-00-0144-vu Logic and Foundations 0 Lecture and 3 Exercise										
2	Study Content										
	Elementary logic: propositional logic and first order logic; syntax, semantics and deductive calculi. Basic axiomatic set theory; set-theoretic construction of basic mathematical entities; ordinal and cardinal numbers. Computability, decidability and recursive enumerability based on a simple model of computation										
3	Learning Outcomes										
	Students understand simple formalisations of mathematical statements in formal systems and can - at an elementary level - handle proofs in a formal system. They can - by means of examples - follow the modelling of general mathematical concepts, constructions and proofs within the framework of set theory. They know the relevance of the fundamental concepts of classical logic and computability theory for foundational issues of mathematics. After the successful completion of the course the students are qualified to discuss questions such as: "What is a true proposition?" "What is a proof?" "What is the difference between sets and classes?" "How to calibrate different levels of infinity?" "In what sense is mathematical knowledge certain?"										
4	Requirements for Participation recommended: basic mathematical knowledge from the first semester										
5	Form of Examination										
	Final Module Examination:										
	Module Examination (Study Examination, Special Form, Passed / Not Passed)										
	Studienleistung: Oral exams in small groups, as well as successful participation in the exercise classes where appropriate.										
6	Requirements on the Award of Credit Points Passing the Studienleistung										
7	Grading Final Module Examination:										
	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed) 										
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik										
9	Literature (examples include) Forster, T.: Logic, Induction and Sets. CUP, 234pp., 2003										

	Kay, R.: The Mathematics of Logic. CUP, 204pp., 2007 Schindler, R.: Logische Grundlagen der Mathematik. Springer, 203pp., 2009
10	Comment
	recommended: Mathematics: Bachelor year 2, Teaching Degrees

Мо	dule nam	ne								
	Prose	eminar								
Module no. 04-10- 0025/deCredit Points 3 CPWorkload 90 h		Self-	Self-study Duration 60 h 1 Semes				ncy . semester			
Language of Instruction German					on responsib iendekan*in					
1	Course	s of the	Module							
Course				name		Workload (CP)	Form of Teaching		Contact Hours per Week
	04-00-0047-ps Prosemin			nar		0		Proseminar		2
	feedback on the methods of presentation employed by the speaker. Every student compiles hi or her talk into a written paper.									ompiles his
3	Learning Outcomes Students are able to - perform literature research - give a clear presentation of a mathematical topic - give a suitable written presentation of said topic - analyze and discuss other's talks with respect to content and method of presentation									
4	_		f or Partic Analysis	ipation and Linear Algebra						
5			aminatio	on: ation (Study Examin	natior	n, Special For	m, Passe	ed / No	t Passed)

	Studienleistung: Oral presentation, written expose, active participation in the discussion about
	the other oral presentations.
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not
	Passed)
8	Usability of the Module
	B.Sc. Mathematik, M. Ed.
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Bachelor year 2

	Pros	eminar								
Module no. 04-10- 0025/en Credit Points 3 CP		Workload 90 h		study 60 h	Duration	-				
	iguage of glish	Instruc	tion			on responsik iendekan*in				
1	Course	s of the	Module		•					
	Course	Course no. Cou		se name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	147-ps	Prosemi	nar		0	Proseminar		2	
2	A simpl matter	may var	ry with th	d to individual stud e instructor's choic rticipant gives a one	e of a hour	general ther	ne. The se n to the se	eminar eminar	⁻ may ha ⁻ . Studei	ave a nts give

3	Learning Outcomes
	Students are able to
	- perform literature research
	- give a clear presentation of a mathematical topic
	- give a suitable written presentation of said topic
	- analyze and discuss other's talks with respect to content and method of presentation
4	Requirements for Participation
	recommended: Analysis and Linear Algebra
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Studienleistung: Oral presentation, written expose, active participation in the discussion about
	the other oral presentations.
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not
	Passed)
8	Usability of the Module
	B.Sc. Mathematik
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Bachelor year 2

Module name												
Intro	Introduction to Mathematical Logic											
Module no. 04-10- 0028/en	Credit Points 9 CP	Workload	270 h	Self-study 180 h	Duration 1 Semester	Frequency Every 2. semester						
Language of English	Instruction			Person responsible for the Module Prof. Dr. phil. nat. Ulrich Kohlenbach								

1	Courses of the	Module								
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week					
	04-00-0148-vu	Introduction to Mathematical Logic	0	Lecture and Exercise	6					
2	compactness t	nantics of first order logic; form heorem; the logical and set-the ry; undecidability and incomple	oretical foundations of		elementary					
3	Learning Outcomes Students understand the basic concepts and methods of mathematical logic and can apply them in connection with the classical theorems of first order logic and the formal concept of proof. They understand the scope of first order logic and can discuss its limitations as expressed by the relevant theorems.									
4	-	for Participation : solid mathematical foundatior	ns in Analysis and Line	ar Algebra						
5	min, St Modu Fachprüfung: L small number of exam. The decident during the first the exam. Studienleistung of the homework		tion, Special Form, Pa n of a written test, ex case, the exam can be n is taken and comm d on the prospective cudent successfully co oportion of necessary	ssed / Not Passe cept when there e taken in the for unicated number of stude mpletes a certain assignments and	d) are only a m of an ora nts taking n proportion					
6	Passing the Fac	on the Award of Credit Points hprüfung ; dienleistung is a prerequisite fo	or taking the Fachprüf	ung						
7	Grading Final Module E	xamination:								

	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik
9	Literature examples of useful literature: Ebbinghaus, Flum, Thomas: Einführung in die mathematische Logik; Shoenfield: Mathematical Logic; Cori, Lascar: Mathematical Logic; Poizat: A Course in Model Theory, an Introduction to Contemporary Mathematical Logic; van Dalen: Logic and Structure; lecture notes where provided
10	Comment recommended: Mathematics: Bachelor year 3 (log), Teaching Degrees

Mod	Module name										
	Algebra										
Module no. 04-10- 0029/de		Credit F	Points 9 CP			Self-study 180 h		Duration 1 Semester		Frequency Every 2. semeste	
Lang	guage of	Instruct	ion			Pers	on responsib	le for the	Modu	ule	
Gerr	nan					Prof.	Dr. rer. nat.	Jan Hend	rik Bru	linier	
1	Course	s of the l	Module								
	Course no. Course			name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	080-vu	Algebra						Lecture and 6 Exercise		6
2	Study C	Content									
	Rings, P	Polynom	ial rings,	Field extension	ons, Ga	alois t	heory, Modu	lles			
3	Learnin	g Outco	mes								
	Studen	ts									
				le to apply th				results tro	eated i	in the co	urse
	- develo	op a basi	c level o	f understandi	ng of (Galois	theory				

	- are able to recognise the treated concepts in various fields of mathematics.
4	Requirements for Participation
	recommended: Introduction to Algebra
5	Form of Examination Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik
9	Literature J.C. Jantzen, J. Schwermer: Algebra, Springer S. Bosch: Algebra, Springer S. Lang: Algebra, Springer T.W. Hungerford: Algebra, Springer
10	Comment recommended: Mathematics: Bachelor year 3 (alg), Teaching Degrees

	Man	ifolds							
Module no. 04-10- 0033/deCredit Points 5 CPWorkload150					Self-study 105 h	Duration 1 Semes	•		ency 2. semeste
	guage of	Instruct	ion		Person responsi	ole for the	e Modu	ule	
Ger	man				Prof. Dr. rer. nat				mann
1	Course	s of the	Module				_		
	Course	no.	Course	name	Workload (CP)	Form Teach	-	Contact Hours per Week
	04-00-0	132-vu	Manifold	ds	0		Lectur Exercis		3
			d Lie der	nifolds, Whitney Em ivative, local flow, F es' Theorem					
3	differer Learnin Studen handle They ca	ntial form ng Outco ts under it forma an illustra	d Lie der ns, Stoke mes stand the lly. ate conte	ivative, local flow, F	robenius Theorer	n;			
3	differer Learnin Studen handle They ca arises r	ntial form ng Outco ts under it forma an illustra	d Lie der ns, Stoke mes stand the lly. ate conte	ivative, local flow, F es' Theorem e coordinate-invaria exts where the man	robenius Theorer	n;			
3	differer Learnin Studen handle They ca arises r They m	ntial form ng Outco ts under it forma n illustra naturally aster the	d Lie der ns, Stoke mes stand the lly. ate conte	ivative, local flow, F es' Theorem e coordinate-invaria	robenius Theorer ant description an ifold description	n;			
3	differer Learnin Studen handle They ca arises r They m and car	ntial form ng Outco ts under it forma in illustra naturally aster the n explain	d Lie der ns, Stoke mes stand the lly. ate conte e formali how the	ivative, local flow, F es' Theorem e coordinate-invaria exts where the man ism of differential fo	robenius Theorer ant description an ifold description	n;			
	differen Learnin Studen handle They ca arises r They m and car general Require	ntial form ng Outco ts under it forma naturally aster the n explain lizes to a ements f	d Lie der ns, Stoke mes stand the lly. ate conte how the rbitrary	ivative, local flow, F es' Theorem e coordinate-invaria exts where the man ism of differential fo e Fundamental Theo dimensions.	robenius Theorer ant description an ifold description orms orem of Calculus	n; d can	algleich	nungen	
4	differen Learnin Studen handle They ca arises r They m and car general Require Lineare Form o	ntial form ng Outco ts under it forma an illustra naturally aster the n explain lizes to a ements f Algebra f Examir	d Lie der ns, Stoke mes stand the lly. ate conte to formali how the rbitrary for Partic , Analysi	ivative, local flow, F es' Theorem e coordinate-invaria exts where the man sm of differential for e Fundamental Theo dimensions. cipation s, Integrationstheor	robenius Theorer ant description an ifold description orms orem of Calculus	n; d can	algleich	nungen	
4	differen Learnin Studen handle They ca arises r They m and car general Require Lineare Form o	ntial form ng Outco ts under it forma an illustra naturally. aster the n explain lizes to a ements f e Algebra f Examir odule Ex	d Lie der ns, Stoke mes stand the lly. ate conte to formali how the rbitrary for Partic , Analysi	ivative, local flow, F es' Theorem e coordinate-invaria exts where the man sm of differential for e Fundamental Theo dimensions. cipation s, Integrationstheor	robenius Theorer ant description an ifold description orms orem of Calculus	n; d can Differentia			Passed)
3 4 5	differen Learnin Studen handle They ca arises r They m and car general Require Lineare Form o Final M	ntial form ng Outco ts under it forma an illustra naturally. aster the n explain lizes to a ements f Algebra f Examir odule Ex Module	d Lie der ns, Stoke mes stand the lly. ate conte to formali how the rbitrary for Partic , Analysi nation caminatic e Examin	ivative, local flow, F es' Theorem e coordinate-invaria exts where the man sm of differential for e Fundamental Theo dimensions. cipation s, Integrationstheor	ant description an ifold description orms orem of Calculus	n; d can Differentia	Passed	d / Not	

_	
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module
	Für B.Sc.Math : Wahlpflichtbereich (B, *)
	Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich
9	Literature
	Lee: Introduction to smooth Manifolds
	Warner: Foundations of differentiable manifolds and Lie groups
	Boothby: An introduction to differentiable manifolds and Riemannian geometry
10	Comment Verantwortlich: Herr Große-Brauckmann (geo)

Mod	dule nam	ne								
	Mani	ifolds								
04-1	Module no.Credit PointsWorkload04-10-5 CP150 I			Self-study Duratio 105 h 1 Semes				ncy . semester		
Lang	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ule	
Engl	ish				Prof	. Dr. rer. nat.	Karsten (Große-	Brauckm	ann
1	Courses	s of the I	Module							
	Course	no.	Course	Course name		Workload ((CP)	Form Teacł	•••	Contact Hours per Week
	04-00-03	132-vu	Manifold	ds		0		Lectur Exercis		3
2	tangent vector f	ntiable n t bundle, fields an	d Lie der	s, hifolds, Whitney Em ivative, local flow, l ss' Theorem		-				

3	Learning Outcomes Students understand the coordinate-invariant description and can handle it formally. They can illustrate contexts where the manifold description arises naturally. They master the formalism of differential forms and can explain how the Fundamental Theorem of Calculus generalizes to arbitrary dimensions.
4	Requirements for Participation Lineare Algebra, Analysis, Integrationstheorie, Gewöhnliche Differentialgleichungen
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Für B.Sc.Math : Wahlpflichtbereich Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich
9	Literature Lee: Introduction to smooth Manifolds Warner: Foundations of differentiable manifolds and Lie groups Boothby: An introduction to differentiable manifolds and Riemannian geometry
10	Comment Verantwortlich: Herr Große-Brauckmann (geo)

Module name									
Diffe	rential Geomet	ry							
	Credit Points	Workload	Self-study	Duration	Frequency				
04-10- 0035/en	5 CP	150 h	105 h	1 Semester	Every 2. semester				

Lan	guage of Instruc	tion		n responsible fo		
Eng	lish		Prof. D	or. rer. nat. Elen	a Mäder-Baumdic	ker
1	Courses of the Course no.	Module Course name	V	Vorkload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0227-vu	Differential Geometry	0		Lecture and Exercise	3
2	surfaces: first f mean curvatur	gth and curvature; fundamental form, Gauß maj e, surfaces of revolution; per nstein polynomials, Bézier cu	rhaps in	trinsic geometr	y;	
3	curves and sur	omes tended this module the stud faces. They know how to des o discuss examples of curves	scribe sı	irfaces in terms		
4	-	for Participation Differentialgleichungen, Line	eare Alg	ebra		
5	Form of Exami Final Module E	xamination:			- Francischier D	
		le Examination (Technical Ex candard)	aminati	on, oral / writte	en Examination, Di	uration 60
	• Modu	le Examination (Study Exami	ination,	Study Examinat	ion, Passed / Not	Passed)
6	Requirements Passing the Fac	on the Award of Credit Poir	nts			
7	Grading Final Module E	xamination:				
	• Modu Standa	le Examination (Technical Ex Ird)	aminati	on, oral / writte	en Examination, W	'eight: 100%,
	Modu Passed	le Examination (Study Exami l)	ination,	Study Examinat	ion, Weight: 0%, F	Passed / Not
8	Usability of the B.Sc.Math mat	e Module th. Wahlbereich; Master: Er	gänzung	sbereich		
9	Literature Bär: Elementar	e Differentialgeometrie Mor	ntiel,			

	Ros: Curves and surfaces Hoschek, Lasser: Grundlagen der Geometrischen Datenverarbeitung
10	Comment
10	Comment Verantwortlich: Herr Reif (geo)

	Func	tional A	nalysis							
Module no. 04-10- 0036/de		Workload 270 h	· · · · · · · · · · · · · · · · · · ·		Duration 1 Semester		Frequency Every 2. semeste			
	guage of man	Instruct	ion			on responsib Dr. rer. nat.				
1	Course	s of the	Module		I					
	Course	no.	Course	name		Workload ((CP)	Form Teach		Contact Hours per Week
	04-00-0	069-vu	Functior	al Analysis		0		Lecture and Exercise		6
		••••		n, Closed Graph The		•		•		
	-	gence; So	obolev sj	a, closed Graph The baces, weak solution ct operators on Bar	n of tl	ne Dirichlet p	roblem;	spectra	al proper	ak ties of
3	linear o Learnin Studen - combi - under	gence; So perators g Outco ts learn t ne ideas stand ar	obolev sj s; compa mes to s from lin nd explai	baces, weak solution	n of th hach s s and funct	ne Dirichlet p paces, spectr topology tional analysi	roblem; s ral theore s	spectra em for	al proper compact	ak ties of t operator:
3	linear o Learnin Studen - combi - under - explai Require recomm	gence; So perators g Outco ts learn t ine ideas stand ar n metho ements f nended:	bolev sj s; compa mes to from lin ds from ds from for Partic Analysis	baces, weak solution ct operators on Bar lear algebra, analysi n basic principles of functional analysis i	n of th nach s s and funct n the y, Con	topology tional analysi context of p	roblem; s ral theore s artial diff	erentia	al proper compact	ak ties of operator

10	Comment recommended: Mathematics: Bachelor year 3 (ana)
9	Literature Alt: Lineare Funktionalanalysis; Conway: A Course in Functional Analysis; Reed, Simon: Functional Analysis: Methods of Modern Mathematical Physics I; Rudin: Functional Analysis; Werner: Funktionalanalysis; Ciarlet: Functional Analysis;
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
6	Requirements on the Award of Credit Points Passing the Fachprüfung ; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.

Module nam	ne				
Parti	al Differential E	quations I			
Module no.	Credit Points	Workload	Self-study	Duration	Frequency

04-10	0-0037		9 CP	270 h		180 h	1 Semest	er	Everv 2	2. semester
		Instruct				on responsib			-	
-	nan and					. Dr. rer. nat.				
1	Courses	of the I	Module							
	Course	ourse no. Course name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-01	L84-vu	Partial Differe	ential Equations	I	0		Lectur Exercis		6
	formula theory o	l treatm ition of e	elliptic bound ev spaces, Ga	ndamental type lary value prob llerkin method	lems	as variational	problem	s, regu	larity th	neory,
	Student - unders - develc	stand an op an adv	d are able to vanced level	apply the notion of understandi pwledge in this	ng of				in the co	ourse
	-		or Participat Functional A							
	Final Ma • Fachprü small nu exam. T	Module min, Sta ifung: Us umber o he decis	amination: e Examination andard) sually the exa f potential pa sion about th	n (Technical Exa am is taken in f articipants. In the e form of the e	orm c his ca xam i	of a written te se, the exam s taken and c	est, except can be tal ommunic	t wher ken in ated c	there a the for luring th	are only a m of an oral ne first two
				on the prospec		umber of stu	dents taki	ing the	e exam.	
	-		nprüfung							
	Grading Final Mo	odule Ex		n (Technical Ex	amina	ation, oral / w	ritten Exa	aminat	tion, We	eight: 100%,
		-	Module k, M.Sc. Mat	hematik, M.Sc.	Math	nematics				

	M.Sc. ETIT
9	Literature L.C. Evans: Partial Differential Equations (AMS) D. Gilbarg, N.S. Trudinger: Elliptic Partial Differential Equations of Second Order (Springer) M. Renardy, R.C. Rogers: An Introduction to Partial Differential Equations (Springer)
10	Comment recommended: Mathematics: Master (ana)

Мо	dule nam Parti	-	rential F	Equations II							
Мо	dule no.			Workload	Self	-study	Duratio	n	Freque	ency	
04-	10-0038		9 CP	270 h		•	1 Semes	ter	Irregul	-	
Lan	guage of	Instruct	tion		Pers	son responsib	le for the	e Mod	ule		
Ger	man and	English			Prof	f. Dr. rer. nat.	Matthias	Hiebe	r		
1	Course	s of the	Module					_			
Course		no.	Course	name	Workload (CP)		Teaching		Contact Hours per Week		
	04-00-0	065-vu	Partial D	ifferential Equations	II 0			Lecture and 6 Exercise		6	
	-	ons with		ce, uniqueness and methods. The conte	•	•					
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of partial differential equations - are able to extend their knowledge in this field - are able perform supervised research in this field										
4	•		f or Partic dependi	cipation ing on the topics co	vereo	d either:					
	- Partia		•								
		- Partial Differential Equations I or:									

	- Partial Differential Equations: Classical Methods (taught in engineering programmes)
5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a
	small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two
	weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Gilbarg, Trudinger: Elliptic Partial Differential Equations of Second Order
	Amann: Linear and Quasilinear Parabolic Problems Dafermos: Hyperbolic Conservation Laws in Continuum Physics
	Galdi: An Introduction to Mathematical Theory of the Navier-Strokes Equations
10	Comment
	recommended: Mathematics: Master (ana)

Mod	Aodule name											
	Elementary Partial Differential Equations											
Module no.Credit PointsWorkload04-10-6 CP180 h					study 120		DurationFrequencyh1 SemesterEvery 2. seme			•		
Language of Instruction German						Person responsible for the Module Prof. Dr. rer. nat. Jens Lang						
1	Courses of the Module											
	Course	no.	Course	name			Workload	l (C	P)	Form	of	Contact

				Teaching	Hours per Week
	04-00-0153-vu	Elementary Partial Differential Equations	0	Lecture and Exercise	4
2	representation physical interpi elliptic differen	f partial differential equations, n s of solutions of the wave equat retation; fundamental solutions tial equations, maximal principles s in special dommains	ion and the heat equat and reen's function fo	tion, r	
3	- die Grundtype L#246;sungsme - Mathematisch	omes uch des Moduls k#246;nnen die en linearer partieller Differential ethoden untersuchen ne Modelle zur Behandlung grur oblemstellungen aufstellen und	lgleichungen mit klassis ndlegender naturwisser	·	
4	-	for Participation sis und Lineare Algebra, gewöhn	liche Differentialgleich	ungen,Integrat	ion
5	• Modul	xamination: e Examination (Study Examinati e Examination (Technical Exami	-		
6	Requirements	on the Award of Credit Points			
7	Passed	e Examination (Study Examinati) e Examination (Technical Exami		-	
8	FürB.Sc.WiMa, M.Sc.WiMa:Erg	icht Für B.Sc.Math, B.Sc.MCS: m B.Sc.ME: math. Wahlbereich Fü gänzungsbereich auch in den Stu ik, Chemie, Maschinenbau, Bau	r M.Sc.Math, Idiengängen der Fachb		

9	Literature
	John: Partial Differential Equations Jost: Partielle Differentialgleichungen Strauss: Partielle Differentialgleichungen Sauvigny: Partielle Differentialgleichungen der Geometrie und Physik. Band1: Grundlagen und Integraldarstellungen
10	Comment

Мо	dule nam Intro	-	to Opt	imization						
04-2	Introduction to Optimizationdule no.Credit PointsWorkload10-9 CP270					h Self-study Duration 180 h 1 Semes				
	guage of man	Instruct	ion			on responsib . Dr. rer. nat.			ule	
1		Courses of the Module Course no. Course name				Workload (CP)	Form Teacl	•••	Contact Hours per Week
	04-00-0023-vu Introduc			tion to Optimization		0		Lecture and Exercise		6
2	duality	sets and in linear	optimiz	ns; introduction to t ation; simplex meth of linear optimizatio	od fo	r the solution	of linea	r optim	nization p	problems;
3	Learning Outcomes Students - are proficient in optimality and duality theory in linear optimization. - are familiar with the basics of the theory of polyedra and convex functions - know basic numerical methods for the solution of linear and quadratic optimization problems. - are able to solve and model applications with linear and quadratic optimization problems.						•			
4	-		or Partio Analysis	cipation , Linear Algebra						
5		f Examir odule Ex	nation kaminatio	on:						

	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung ; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik M.Sc. ETIT
9	Literature Chvatal: Linear Programming Geiger, Kanzow: Theorie und Numerik restringierter Optimierungsaufgaben; Jarre, Stoer: Optimierung Nocedal; Wright: Numerical Optimization; Schrijver: Theory of Linear and Integer Programming; Ziegler: Lectures on Polytopes
10	Comment recommended: Mathematics: Bachelor year 3 (opt), Teaching Degrees

Мо	dule nam	ne								
	Opti	mizatio	n in Ind	ustry	-					
Module no.Credit PointsWorkload04-10-5 CP150 I					Self-s	-	Duration 1 Semes		Freque Every 2	e ncy 2. semester
Lan	guage of man	Instruct	ion		Perso	on responsib	le for the	e Modu	ıle	
1	7	o of the l	Madula							
I	Courses of t Course no.		Course	name	,	Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	136-vu	Optimiza industry	ation in economy and	C)		Lecture Exercis		3
3	 mathematical modelling; introduction to the theory of two-person games; principle of duality and its applications; solving linear programming problems with many variables; solving integer valued linear programming problems; statical and dynamical networking problems Learning Outcomes Nach dem Besuch des Moduls können sie praktische Problemstellungen auf der Basis von linearer und ganzzahliger Optimierung mathematisch modellieren kennen sie Lösungsverfahren für solche Probleme (Branch and Bound, Schnittebenen, Spaltengenerierung, Heuristiken) verstehen sie die besondere Bedeutung von Dualitätsaspekten in Spieltheorie, 									
4	Netzwerktheorie und Linearer Programmierung Requirements for Participation Mindestens Kenntnisse der Linearen Programmierung; Programmierkenntnisse möglichst in C++ Form of Examination									
 Final Module Examination: Module Examination (Technical Examination) Module Examination (Study Examination, Stu 						ion Tochnic	al Evami		Stand	
	•									-

7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Für B.Sc.WiMa., B.Sc.ME: math. Wahlbereich (Optimierung); Für B.Sc.Math, B.Sc.MCS: C; Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich (Optimierung); Für CE: als mathematisches Wahlmodul
9	Literature Nemhauser, Wolsey: Integer and Combinatorial Optimization Ahuja, Magnanti, Orlin: Network Flows: Theory, Algorithms, and Application
10	Comment

Mo	dule nam	ne								
	Num	erical N	/lethods	for Ordinary Diff	eren	tial Equatior	ns for En	ginee	rs	
04-1	dule no. 10- 2/de	Credit	Points 5 CP	Workload 150 h		- study 105 h	Duratior 1 Semes	-	Freque Every 2	e ncy 2. semeste
Ger	guage of man				Prof	on responsib . Dr. rer. nat. selmann				. nat. Jan
1	Courses of the Module Course no. Course nar			name	Workload (CP)			Form of Teaching		Contact Hours per
						0	1			Week
	04-10-0	134-vu		s of ordinary differen ns - Initial value probl		0		Lectur Exercis		3
2	stability	alue pro /; ary-value		ne-step methods, r ns: Shooting metho		·		-		

3	Learning Outcomes
•	Students know the basic numerical solution concepts for ordinary differential equations and
	they are able to analyze, compare, and apply them.
4	Requirements for Participation
	recommended: Analysis, Linear Algebra, Ordinary Differential Equations, Introduction to Numerical Analysis or similar knowledge as taught in an engineering programme.
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung ; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics M.Sc. ETIT
9	Literature Deuflhard, Bornemann: Numerische Mathematik 2 Stoer, Bulirsch: Numerische Mathematik 2
10	Comment recommended: Mathematics: Bachelor year 3 (num)

Мо	dule nan	ne									
		erical Li	near Al	gebra	1		[1		
Module no. Credit Points Workload					Self-study		Duratio	n	Freque	ncy	
04-10- 0043/de			5 CP	150 h		105 h	1 Semester		Every 2. semester		
Language of Instruction					Person responsible for the Module						
	man	motract				er. nat. Alf G		e mout			
1	Course	s of the l	Module		ļ						
	Course no.		Course	name		Workload (CP) Form of Teaching		-	Contact Hours per Week		
	04-00-0	139-vu	Numeric	al Linear Algebra		0		Lectur Exercis		3	
	Systems of linear equations: iterative methods, singular value decomposition, eigenvalue problems.										
3	Learning Outcomes Students know about the most important numerical methods of linear algebra and they are able to explain, classify, and apply them.										
4	-	ements f nended:		cipation Igebra, Introductior	n to N	umerical Ana	alysis or s	imilar l	knowled	lge	
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) 										
	•	Module Examination (Technical Examination, Technical Examination, Standard)									
	small n exam. 1 during	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an ora exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.									
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.										

6	Requirements on the Award of Credit Points
	Passing the Fachprüfung;
	Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
	M.Sc. ETIT
9	Literature
	Trefethen/Bau: Numerical Linear Algebra, SIAM
	Demmel: Applied Numerical Linear Algebra, SIAM
	Stoer/Bulirsch: Numerische Mathematik 2, Springer
10	Comment
	recommended: Mathematics: Bachelor year 3 (num)

Мос	dule nan	ne							
	Num	erical L	inear Al	gebra					
Module no. 04-10- 0043/en		Credit	Credit Points Workload 5 CP 150 h		Self-study 105	Self-study Duratic 105 h 1 Seme		•	
Lanք Engl	guage of lish	Instruc	tion		Person respons Dr. rer. nat. Alf (e Modu	le	
1	Courses of the Module								
	Course no. Course		name	Workload	Workload (CP) Form Teac			Contact Hours per Week	
	04-00-0139-vu Numerio		al Linear Algebra	0		Lecture Exercise		3	
2	-		ar equati	ons: iterative meth	ods, singular valu	e decomp	osition,	eigenv	value

3	Learning Outcomes Students know about the most important numerical methods of linear algebra and they are able to explain, classify, and apply them.
4	Requirements for Participation recommended: Linear Algebra, Introduction to Numerical Analysis or similar knowledge
5	Form of Examination Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Trefethen/Bau: Numerical Linear Algebra, SIAM Demmel: Applied Numerical Linear Algebra, SIAM Stoer/Bulirsch: Numerische Mathematik 2, Springer
10	Comment

Мо	dule nam	ne									
	Intro	duction	to Mat	hematical Model	ling						
04-	Module no.Credit PointsWorkload04-10-5 CP		Workload 150 h	Self	- study 90 h	Duration 1 Semester		Frequency Every 4. semester			
Language of Instruction German					Person responsible for the Module Prof. Dr. rer. nat. Jens Lang						
1	Courses of the Module										
	Course no.		Course	name		Workload (CP)		Form Teacl	-	Contact Hours per Week	
	04-00-0	140-vu	Introduc Modellir	tion to Mathematical ng		0		Lectur Exercis		4	
2	Study Content basic concepts, statical linear, non-linear and discrete systems, dynamical systems in one and more dimensions, systems with opponent, random.									one and	
3	Learning Outcomes Students understand and are able to apply the basic techniques of mathematical modeling. The are aware of particular solution concepts for exemplary applications and understand the underlying mathematical structures. The students are able to apply known modeling technique to further applications and to interprete the results.									the	
4	-		or Partic Analysis	ipation , Linear Algebra							
 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Duration, Standard) 											
	Fachprüfung (technical examination): Usually the exam is taken in form of a written when there are only a small number of potential participants. In this case, the exar taken in the form of an oral exam. The decision about the form of the exam is take communicated during the first two weeks of the lecture, based on the prospective students taking the exam.								e exam s taken	can be and	

	Studienleistung (study examination): Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik
9	Literature lecture notes
10	Comment recommended: Mathematics: Bachelor year 3, Teaching Degrees

Mo	Module name											
	Prob	ability 1	Theory									
Module no. 04-10- 0045/deCredit Points 9 CPWorkload270 h					If-study Duration 180 h 1 Semester			Frequency Every 2. semester				
	Language of Instruction German 1 Courses of the Module					Person responsible for the Module Prof. Dr. rer. nat. Michael Kohler						
	Course	Course no. Course		name		M	/orkload ((CP)	Form Teach	••	Contact Hours per Week	
	04-00-0	04-00-0141-vu Probability Theory			0			Lecture Exercis		6		

2	Study Content
	Measure theoretical foundations, theory of integration, random variables, concepts of convergence, characteristic functions, stochastic independence, 0-1-laws, conditional expectations, martingales in discrete time, limit theorems: law of large numbers, central limit theorem.
3	Learning Outcomes Students
	 - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of probability theory - are able to recognise the treated concepts in various fields of mathematics.
4	Requirements for Participation recommended: Analysis, Integration Theory, Introduction to Stochastics
5	Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung ; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik

9	Literature
	Bauer: Probability Theory Billingsley: Probability and Measure
	Elstrodt: Maß-und Integrationstheorie
	Gänssler, Stute: Wahrscheinlichkeitstheorie Klenke: Wahrscheinlichkeitstheorie
10	Comment
	recommended: recommended: Mathematics: Bachelor year 3 (sto), Teaching Degrees

Mo	dule nam	-								
Module no. 04-10- 0045/en		ability Theory Credit Points 9 CP		Workload 270 h	Self-study 180 h		Duration 1 Semester		Frequency Every 2. semeste	
Language of Instruction English						on responsib . Dr. rer. nat.				
1	Courses of the Course no.					Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0071-vu Probab			ity Theory	0		Lecture and Exercise		6	
2	conver	e theore gence, cl ations, m	naracteri	indations, theory of stic functions, stoch es in discrete time,	nastic	independen	ce, 0-1-la	ws, coi	nditiona	I
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of probability theory - are able to recognise the treated concepts in various fields of mathematics.									
4	-		or Parti o Analysis	cipation , Integration Theory	, Intr	oduction to S	itochasti	CS		
5		f Examir odule Ex	nation kaminatio	on:						

	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung;
	Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik
9	Literature Bauer: Probability Theory Billingsley: Probability and Measure Elstrodt: Maß-und Integrationstheorie Gänssler, Stute: Wahrscheinlichkeitstheorie Klenke: Wahrscheinlichkeitstheorie
10	Comment recommended: Mathematics: Bachelor year 3 (sto), Teaching Degrees

Module name

Introduction to Mathematical Finance

										1		
	ule no.	Credit F	oints	Workload		Self-	study	Duration		Freque	ncy	
04-1			5 CP		150 h		105 h	1 Semest	ter	Every 2	. semester	
0047	-											
_	-	Instruct	ion				on responsi					
Gerr						Prot	Dr. rer. nat	IVIICNAEI K	Conier			
1	Courses	s of the	Module				[1			
	Course no.		Course name				Workload (CP)	Form of Teaching		Contact Hours per Week	
	04-00-00	084-vu	Introduc Finance	tion to Math	ematical		0		Lecture Exercis		3	
2	Study C	ontent										
	-	reises, l					II, stochastis Bewertung	-		-		
3	Student - under	stand an	id are ab				nethods and ial mathema		eated i	in the co	ourse	
4	-		or Partic Introduc	-	chastics,	Prob	ability Theo	Ŷ				
5	Form o	f Examir	nation									
	Final M	odule Ex	aminatio	on:								
	•	Modul	e Evamin	ation (Study	v Evami	natior	n, Special Fo	m Passe	d / No	t Passed	0	
	•	Wioduk				ation	i, special lo	11, 1 0350	u / NO	t i assea	•)	
	•	Module	e Examin	ation (Tech	nical Exa	amina	ition, Techni	cal Examir	nation,	, Standa	ard)	
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an ora exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.								n of an oral			
	of the h	omewo	rk assign	ments. The	precise	prop	ent success ortion of neo structor duri	essary ass	signme	ents and		
6	-		on the Av	ward of Cre	dit Poin	ts						
7	Gradin	3										

	Final Module Examination:								
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) 								
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) 								
8	Usability of the Module								
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics								
9	Literature								
	Bingham, Kiesel: Risk-Neutral Valuation;								
	Elliott, Kopp: Mathematics of Financial Markets;								
	Irle: Finanzmathematik;								
	Musiela, Rutkowski: Martingale Methods in Financial Modelling;								
	Pliska: Introduction to Mathematical Finance;								
	Shreve: Stochastic Calculus for Finance I (Discrete Time Models)								
10	Comment								
	recommended: Mathematics: Bachelor year 3 (sto)								

	Life I	nsuran	ce Math	ematics								
Module no. 04-10- 0049/de		Credit Points 5 CP		Workload 150 h	Self-study 105 h		Duration 1 Semester		Frequency Irregular			
Lan	guage of	Instruc	tion		Pers	on responsib	le for the	e Modu	Jle			
Ger	man				Prof	Dr. rer. nat.	Frank Au	rzada				
1	Course	Courses of the Module										
	Course	no.	Course	name		Workload ((CP) Form of Teaching		-	Contact Hours per Week		
	04-00-0162-vu Life Insu			rance Mathematics		0		Lectur Exercis		3		
2	Study C	Content										
	0. Basic	0. Basic principles of insurance contracts										
				mathematics								
				l variation, Lebesgu	e-Stie	ltjes integral						
				, actuarial reserve								
		4. Basic notions of life insurance mathematics, examples										
	5. The	5. Thiele's integral equation										

	6. Conditional expectations, martingales7. Hattendorf's theoremPotential societal implications will be addressed in the lecture.
3	Learning Outcomes - understand basic principles of insurances - get to know the main model of life insurance mathematics - be able to compute a premium flow - be able to design new types of insurance contracts and compute the respective premium flow - basic properties of martingles
4	Requirements for Participation Recommended: Einführung in die Stochastik \ Maß- und Integrationstheorie \ Concurrent attendance of the lectur Probability Theory
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated by the instructor during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc.Math, B.Sc.WiMa: Wahlpflichtbereich Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich
9	Literature Klaus D. Schmidt: Versicherungsmathematik. Springer.
10	Comment

Мо	dule nan	ne									
	Non-	Acaden	nic Inter	nship							
Module no. 04-10- 0051/de		Credit Points 5 CP		Workload 150 h	Self-	study 150 h	Duration 1 Semester		Frequency Every semester		
Language of Instruction German						on responsib iendekan*in					
1	Courses of the Module										
	Course	Course no. Cou		e name		Workload (CP)		Form of Teaching		Contact Hours per Week	
2		ering or		ip in a company or k environment of a				n in a lo	ocation	reflecting	
3	Learning Outcomes The students experience a realistic working environment for mathematicians. They can work in teams and have an idea how mathematicians may work and can report on it.										
4	Requirements for Participation Students need to find and organize their internship on their own.Internships need to be suitable for mathematicians. If this is the case only for parts of the internship, ist duration needs to be proportionally greater. Suitability for mathematicians is determined by a lecturer of the department of mathematics.										
5	Form of Examination										
	Final Module Examination:										
	Module Examination (Study Examination, Special Form, Passed / Not Passed)										
		modul		ation (Study Exami	ation	n, Special For	m, Passe	d / No	t Passed	I)	
	Studier			nation (Study Examinentation and oral presentation		•					
6	Require	ements o	: Writter		ion fo	or co-supervis					
6 7	Require Passing Grading	ements of the Stud	: Writter on the Av	n and oral presentat ward of Credit Poin ung (oral and writte	ion fo	or co-supervis					

8	Usability of the Module B.Sc. Mathematik (only PO 2011), M.Sc. Mathematik, M.Sc. Mathematics (only PO 2011 and PO 2018)
9	Literature
10	Comment 4 weeks / 150 hours of internship recommended: Mathematics: Bachelor year 3 (only PO 2011) or Master (only PO 2011 and PO 2018)

Мо	dule nan	ne									
	Non-	Acaden	nic Inter	nship					-		
04-	dule no. 10- 51/en	Credit Points 5 CP		Workload		study Duration 150 h 1 Semes				ency 2. semester	
Language of Instruction						on responsib iendekan*in					
1	Course	s of the l	Module								
	Course	Course no. Course		name		Workload (CP)		Form Teach	-	Contact Hours per Week	
2	volunte	-		iip in a company o k environment of				n in a le	ocation i	reflecting	
3	The stu		perience	e a realistic workin how mathematici	-				. They ca	an work in	
4	Requirements for Participation Students need to find and organize their internship on their own.Internships need to be suitable for mathematicians. If this is the case only for parts of the internship, ist duration needs to be proportionally greater. Suitability for mathematicians is determined by a lecturer of the department of mathematics.										
5		f Examin odule Ex		on:							

	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Studienleistung: Written and oral presentation for co-supervising lecturer at the department.
6	Requirements on the Award of Credit Points
	Passing the Studienleistung (oral and written presentation)
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik (only PO 2011), M.Sc. Mathematik, M.Sc. Mathematics (only PO 2011 and PO 2018)
9	Literature
10	Comment
	4 weeks / 150 hours of internship
	recommended: Mathematics: Bachelor year 3 (only PO 2011) or Master (only PO 2011 and PO 2018)

Мос	dule nam	ne									
	Proje	ect in M	athema	tics (Bachelor)							
Module no.Credit PointsW04-10-5 CP0053/de		Workload 150 h	Self-s	•	Duration 1 Semester		Frequency Irregular				
Lang Gerr	guage of man	Instruct	ion			n responsib Dr. rer. nat.			ule		
1	Courses of the Module										
	Course	no.	Course	name	Workload (CP) Form of Conta Teaching Hours per Week						
2											

	project.
3	Learning Outcomes Students are able to find solution strategies for a given complex problem. They are able to split the problem into appropriate subproblems, solve them and present them to an audiance. Depending on the topic, they may also do experiments and use software.
4	Requirements for Participation recommended: depending on topic
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Studienleistung: Giving an oral presentation about the results of the project.
6	Requirements on the Award of Credit Points Passing the Studienleistung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik
9	Literature depending on topic
10	Comment recommended: Mathematics: Bachelor year 3 instead of a seminar. May be the starting point of a bachelor thesis.

Module name											
Project in Mathematics (Bachelor)											
Module no. 04-10- 0053/en	Credit Points 5 CP	Workload 150 ł	Self-study 150 h	Duration 1 Semester	Frequency Irregular						
Language of English	Instruction		Person responsit Prof. Dr. rer. nat.		ule						

1	Courses of the	Module			
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
2	ended; a final j subject matter progress. In co	works on a complex proble precise and focussed fomul content will depend on the nclusion, there will be a pre port in writing, preferably i	ation may be a part of the p e problem. Regular reports esentation in which the res	project. The cor describe the wo ults are describe	orete ork in ed and
3	the problem in	omes ble to find solution strategi to appropriate subproblem the topic, they may also do	is, solve them and present	them to an aud	•
4	-	for Participation : depending on topic			
5			•		d)
6	Requirements Passing the Stu	on the Award of Credit Po Idienleistung	ints		
7	Grading Final Module E • Modu Passed	le Examination (Study Exan	nination, Special Form, Wei	ght: 100%, Pass	ed / Not
8	Usability of the B.Sc. Mathema				
9	Literature depending on t	topic			
10	Comment recommended a bachelor the	: Mathematics: Bachelor ye sis.	ear 3 instead of a seminar. I	May be the star	ting point of

Мо	dule nam	ne									
	Appli	ied Prod	of Theoi	Y							
04-1	dule no.	Credit F		Workload 270 h		Self-study Duration 180 h 1 Seme		•		-	
Lan Eng	guage of lish	Instruct	ion		Person responsible for the Module Prof. Dr. phil. nat. Ulrich Kohlenbach						
1	Courses	s of the l	Module								
	Course	no.	Course	name		Workload ((CP)	Form of Teaching		Contact Hours per Week	
	04-00-03	Applied	Proof Theory		0		Lectur Exercis		6		
interpretations together with applications to various areas of mathematics such approximation theory, nonlinear analysis and ergodic theory. These applications with the extraction of effective bounds and new qualitative uniformity results fr ineffective proofs. The main techniques studied are: Herbrand theory, no-count interpretation (Kreisel), modified realizability (Kreisel), Gödel's functional ('Diale interpretation, negative translation (Gödel), functional interpretation of full ana monotone interpretations and their extensions to systems based on classes of a (nonseparable) metric, hyperbolic and normed spaces						ons are o s from p unterexa alectica inalysis (rima facie imple ') (Spector),				
3	Student 1) unde (also in 2) have interpre 3) unde general 4) can a	erstand a higher t comma etation, f erstand t classes apply suc	ind are a ypes); nd of the monotor he logica of abstra ch metat	ble to use formal ca e treated proof inte ne functional interp al metatheorems pr act spaces) and can heorems on their o nalysis (approximat	rpreta retation esento assess wn (es	ations (modif on); ed (both for s s their scope .g. in the con	ied realiz specific p of applic text of a	ability, olish s _l ability; master	functio paces as r thesis)	nal well as for to suitable	
4		nended:	or Partic Introduc	cipation ction to Mathemation	cal Lo	gic, Introduct	ion to Cc	omputa	ibility Th	neory	
5		f Examir odule Ex	nation caminatio	on:							

	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Kohlenbach, U.: Applied Proof Theory: Proof Interpretations and Their Use in Mathematics. Springer Monograph in Mathematics, xx+536pp., 2008
10	Comment recommended: Mathematics: Master (log) Due to content overlap, this course cannot be combined with Basic Applied Proof Theory oder Advanced Applied Proof Theory eingebracht werden.

Мос	Module name										
	Introduction to Computability Theory										
Module no.Credit PointsWorkload04-10-5 CP150						Self-studyDurationFrequency105 h1 SemesterIrregular					
Language of InstructionPerson responsible for the ModuleEnglishProf. Dr. phil. nat. Ulrich Kohlenbach											
1	Course	s of the	Module								
Course no. Course name				Workload ((Workload (CP)		of ning	Contact Hours per Week			
	04-00-0	167-vu	Introduc	tion to Computabilit	y	0		Lecture	e and	3	

	T
	Theory Exercise
2	Study Content This course gives a brief introduction to classical recursion (computability) theory culminating in the solution of Post's problem by the priority method (Friedberg/Muchnik). Table of contents: the basic machine, definition of recursive functions, codes and indices, Kleene normal form theorem, Kleene recursion theorem, Church's thesis, relative recursion, arithmetical hierarchy, recursively enumerable relations, Turing degrees, solution of Post's problem, computable functionals.
3	 Learning Outcomes Students 1) understand and can apply the basic theorems of classical computability theory (Kleene normal form, S-m-n theorem, recursion theorem); 2) can classify arithmetically defined predicates according to their complexity in the arithmetical hierarchy; 3) understand the various concepts of reducibility and their relation (many-one, truth-table, Turing); 4) have a basic understanding of the priority method due to Friedberg and Muchnik and are able to learn on their own from additional literature.
4	Requirements for Participation recommended: Introduction to Computability Theory Alternatively: Logic as taught in CS programmes
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature

	Shoenfield, Joseph R.: Recursion Theory. ASL and A K Peters, 96pp., 2001. Cutland, Nigel J.: Computability. Cambridge University Press 1980.
10	Comment recommended: Mathematics: Master (log)

Мос	dule nam	ne									
	Mod	al Logic	s						•		
Module no. 04-10- 0061/en		Credit Points 5 CP		Workload Self-s		- study 105 h	Duration 1 Semes	•		-	
Language of Instruction English						on responsib . Dr. rer. nat.			ule		
1	Course	s of the	Module								
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week	
	04-00-0170-vu Mo		Modal L	ogics	0		Lecture and Exercise		3		
	modal l	ogics; re	elevant e	st-order logic; class xtensions of basic m ed logics)		•				•	
3	Learning Outcomes Students understand and are able to apply the essential model-theoretic notions relevant for the study of modal logics as treated in the course. They have developed an advanced level of understanding of several systems of modal logics in terms of expressiveness, axiomatisability and algorithmic properties, which enables them to extend their knowledge in this field and allows them to conduct related research under supervision.										
4	recomm	nended:		ipation tion to Mathemation ught in CS program		gic.					
5		f Examir odule E>	nation kaminatio	on:	_						

	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Blackburn, de Rijke, Venema: Modal Logic Goranko, Otto: Model Theory of Modal Logics, in: Handbook of Modal Logic, Blackburn, van Benthem, Wolter (eds)
10	Comment recommended: Mathematics: Master (log)

Mo	dule nam	ne									
	Num	erical A	nalysis	of Hyperbo	lic Equ	atior	IS				
Module no.Credit PointsWorkloadSelf-studyDurationFrequency04-10-00715 CP150 h105 h1 SemesterIrregular										•	
04-1	LO-0071		5 CP		150 h		105 h	1 Semes	ter	Irregula	r
Language of InstructionGerman and English1Courses of the Module						Person responsible for the Module Prof. Dr. rer. nat. Jens Lang					
	Course no. Course name					Workload ((CP)	Form Teach	•	Contact Hours per Week	
	04-00-0	156-vu	Numeric Equatior	al Analysis of Is	Hyperb	olic	0		Lecture Exercis		3

2	Study Content Hyperbolic Equations: Classical solutions, weak solution consistence, CFLcondition, convergence, finite volumne, higher order methods, boundary conditions.
3	Learning Outcomes Students know about the basic numerical solution strategies for hyperbolic differential equations. They are able to explain, analyse, implement, and compare these methods.
4	Requirements for Participation recommended: Numerical Analysis of Ordinary Differential Equations
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature LeVeque: Finite Volume Methods for Hyperbolic Problems, Cambridge University Press 2003; Großmann/Roos: Numerik Partieller Differentialgleichungen, Teubner 2005.
10	Comment recommended: Mathematics: Master (num)

Module name

Nonlinear Optimization

04-1	dule no. LO- 4/de 9 CP 270 h						Self-studyDurationFrequency180 h1 SemesterEvery 2. semester																										
-	guage of man and	Instruct English	ion				o <mark>n responsik</mark> Dr. rer. nat.			ıle																							
1	Course	s of the I	Module																														
	Course	no.	Course	name			Workload (CP)				Workload (CP)		Workload (CP)		Workload (CP)		Workload (CP)		Workload (CP)		Workload (CP)		Workload (CP)		Workload (CP)		Workload (CP)		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	174-vu	Nonlinea	ar Optimizati	on		0		Lecture Exercis		6																						
2	theory;	ing of pra method	s for und	constrained	problen	ns: Lin	n problems; esearchand :-, multiplier	Trust-Reg	gion-M	ethods	•																						
3	Studen - can m - know propert - know	odel pra methods ies the optiu methods	ctical op s for the mality th	solution of eory of nor	unconst nlinear o	rainec ptimiz	athematical I optimizatio ation and an ptimization	on probler re able to	ns and apply i	l their c it	onvergence																						
4	•		or Partic Introduc	cipation ction to Opt	timizatio	'n																											
5			aminatio e Examin		nical Ex	amina	tion, oral / v	vritten Exa	aminat	ion, Du	iration 90																						
	•	Module	e Examin	ation (Stud	y Exami	nation	, Study Exar	nination,	Passed	d / Not	Passed)																						
	small n exam. 1	umber o The decis the first	f potenti sion abou	ial participa ut the form	nts. In tl of the e	his cas xam is	f a written to e, the exam taken and o n the prospo	can be ta communic	ken in ated	the for	m of an oral																						
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.																																

Requirements on the Award of Credit Points
Passing the Fachprüfung;
Passing the Studienleistung is a prerequisite for taking the Fachprüfung
Grading
Final Module Examination:
• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
• Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
Usability of the Module
B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
Literature
Geiger, Kanzow: Numerische Verfahren zur Lösung unrestringierter Optimierungsaufgaben Geiger, Kanzow: Theorie und Numerik restringierter Optimierungsaufgaben Nocedal, Wright: Numerical Optimization
Comment
recommended: Mathematics: Master (opt)

Мос	dule nam	ne									
	Hold	ing Exei	rcise Cla	sses							
Мос	dule no.	Workload	Self-	study		Duration	n	Frequen	су		
04-1	0-0077		3 CP	90 h			90 h	1 Semest	ter	Every se	mester
Lang	guage of	Instruct	ion		Pers	on resp	onsib	le for the	Modu	ıle	
Gerr	man and	English			Stud	iendek	an*in	des Facht	pereich	าร 04	
1	Course	s of the l	Module								
	Course	name		Workl	oad ((CP)	Form Teacł	•.	Contact Hours per Week		
	04-00-0	049-ku	Holding	Exercise Classes		0			Course		0
2	Study Content Participation in tutor training incl. trainers visiting the trainee's classes, Preparing and tutoring an exercise class, Grading of written exercises, Participation in preparatory meetings										
3	Learnin	g Outco	mes								
	Studen	ts learn t	to								

- explain mathematics and recognise typical problems in understanding mathematics
- talk freely in front of larger classes
- handle questions spontaneously and moderating classes
- learn new mathematical material on their own
Requirements for Participation
mathematical and didactical prerequisites, depending on the class held
Form of Examination
Final Module Examination:
Module Examination (Study Examination, Special Form, Passed / Not Passed)
Studienleistung: Active participation in the programme for the training of student instructors,
including visits to the exercise class during the semester; successfully delivering an exercise
class, including active participation at the preparation sessions. Positive evaluation of the
personal performance by the lecturer. A short report may be required.
Requirements on the Award of Credit Points
Passing the Studienleistung
Grading
Final Module Examination:
Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not
Passed)
Usability of the Module
M.Sc. Mathematik, M.Sc. Mathematics
Literature
Comment

Module nam	Module name											
Hold	ing Exercise Cla	sses										
Module no. 04-10- 0077/en	Credit Points 3 CP	Workload 90 h	Self-study 90 h	Duration 1 Semester	Frequency Every semester							
Language of German	Instruction		Person responsible for the Module Studiendekan*in des Fachbereichs 04									

1	Courses of the	Module			
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0049-ku	Holding Exercise Classes	0	Course	0
2		tutor training incl. trainers v s, Grading of written exercise	-		-
3	- talk freely in f - handle questio		erating classes	ling mathematic	S
4	-	for Participation and didactical prerequisites, c	depending on the class h	eld	
5	Studienleistung including visits class, including		programme for the train he semester; successfull reparation sessions. Posi	ing of student in y delivering an e tive evaluation c	structors, exercise
6	Requirements of Passing the Stu	on the Award of Credit Point dienleistung	ts		
7	Grading Final Module Ex Modul Passed	e Examination (Study Examin	nation, Special Form, We	ight: 100%, Pass	ed / Not
8	Usability of the M.Sc. Mathema	e Module atik, M.Sc. Mathematics			
9	Literature				
10	Comment recommended:	Mathematics: Master			

Mod	lule nam	ie										
	Project in Mathematics (Master)											
Mod	lule no.	Credit F	oints	Workload	Self-	study	Duration		Frequency			
04-1	0-0080		5 CP	150 h		150 h	1 Semes	ter	Irregular			
-	-	Instruct	ion			on responsib						
Gerr	nan and	English			Stud	liendekan*in	des Facht	pereich	ıs 04			
1	Courses	s of the l	Module			T				1		
	Course	no.	Course	name		Workload (0	CP)	Form of Teaching		Contact Hours per Week		
	04-10-00	080-ku	Project i	n Mathematics (Maste	er)	0		Project	:	0		
2	ended; subject progres	group w a final p matter o ss. In con ed. A rep	recise ar content iclusion,	a complex problem nd focussed fomulat will depend on the p there will be a preso riting, preferably in	ion m proble entat	nay be a part em. Regular r ion in which t	of the pro eports de the result	oject. T escribe s are d	The concr the work lescribed	rete c in and		
3	Student the pro	blem int	le to find o approp	d solution strategies priate subproblems, , they may also use s	solve	e them and p						
4	Require	ements f	or Partio	cipation								
	recomn	nended:	dependi	ing on topic								
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Studienleistung: Giving an oral presentation about the results of the project. 											
6	Requirements on the Award of Credit Points Passing the Studienleistung											
7	Grading Final Module Examination:											

	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Master

Mo	dule nan	ne								
	Теас	hing an	d Learni	ing Mathematics						
04-1	Module no. 04-10- 0086/de		Points 6 CP	Workload Sel		study 120 h	Duration 1 Semester		Frequency Every 2. semeste	
	guage of man	Instruct	ion			on responsib . Dr. phil. nat			ıle	
1	Course	s of the	Module							
			Course	name		Workload (CP)		Teaching He		Contact Hours per Week
	04-00-0	179-vu	Teaching Mathem	g and Learning of atics		0		Lecture and Exercise		4
2	Models	Content of teach oment of	-	hematics, theory of ences	ftasks	s, types of lea	rning goa	ls, me	thods fo	r long-term
3	The stu		e able to	o use different theo ning situations for h		•		•	• •	•
4	-	ements f nended:		cipation and Linear Algebra	or ec	quivalent				
5		f Examir odule E>		on:						

	1
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	Passed)
8	Usability of the Module B.Sc. Mathematik
9	Literature lecture notes Bruder,R., Leuders,T., Büchter,A. (2008): Mathematikunterricht entwickeln, Cornelsen Verlag Scriptor; Bruder, R., Hefendehl-Hebeker, L., Schmidt-Thieme, B. Weigand, HG. (Hrsg.)(2015), Handbuch der Mathematikdidaktik. Springer Berlin Heidelberg

Module nam	Module name													
Теас	Teaching and Learning Mathematics (LaG)													
Module no.	Credit Points	Workload		Self-study		Duration	Frequency							
04-10- 0087/de	10 CP		300 h	•		2 Semester	Every 2. semester							

Lang	guage of Instruc	tion	Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger						
Geri	man								
1	Courses of the	Module							
	Course no.	Course name	Workload (CP)		Form of Teaching	Contact Hours per Week			
	04-00-0107-ps	Specialized didactics for undergraduates	0		Proseminar	0			
	04-00-0179-vu	Teaching and Learning of Mathematics	0		Lecture	4			
	04-10-0322-vl	Variety of mathematical tasks (online)	6 0		Lecture	0			
2		ule "Lehren und Lernen von I Fachdidaktisches Prosemina		", "Mathema	atische Aufgaben	wielfalt			
3		omes ule "Lehren und Lernen von I Fachdidaktisches Prosemina		", "Mathema	atische Aufgaben	wielfalt			
4	Siehe Teilmodu	for Participation ule "Lehren und Lernen von M Fachdidaktisches Prosemina		", "Mathema	atische Aufgaben	wielfalt			
5	Form of Exami Final Module E • Modu		amination,	Technical Exa	mination, Stand	dard)			
6	Requirements	on the Award of Credit Poin	its						
7	Grading Final Module Examination: • Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)								
8	Usability of th Pflichtmodul fi								
9	Literature Siehe Teilmodule "Lehren und Lernen von Mathematik", "Mathematische Aufgabenvielfalt (online)" und "Fachdidaktisches Proseminar"								
10	Comment								

Mo	Proje dule no.			tical Didactics							
-	10-	Credit		Workload		-study	Duratio		Frequ	-	
	38/de		6 CP	180 h		180 h	1 Seme	ster	Every	2. semester	
Lan	guage of	Instruc	tion		Person responsible for the Module						
Ger	rman				Prof	. Dr. phil. nat	. Katja K	rüger			
1	Course	s of the	Module								
	Course	no.	Course	name		Workload ((CP)	Form Teacl	-	Contact Hours per Week	
	04-00-0	038-pj	-	specific project: Analy ng efficiency for atics	/sis	0		Project		0	
	04-00-0	039-pj	Subject- schools	Subject-specific project: Algebra in schools		0		Project		0	
	04-00-0	043-pj	Subject- Solving	specific project: Probl	ems	ns 0		Project		0	
	04-00-0	4-00-0113-pj Subject-specific project: C Application-oriented mathematical lessons		0 Pr		Projec	t	0			
	04-00-0	292-рј	Subject- in schoo	specific project: Analy ls	/sis	0 Proje			t	0	
2	Study C Siehe T	C ontent eilmodu	ile					·			
3		g Outco eilmodu									
4	-		for Partic Grundlag	c ipation gen des Lehrens und	l Lerr	iens von Math	nematik'	'abges	chlosse	n	
5		f Exami odule E	nation xaminatio	on:							
	•	Modul	e Examir	ation (Technical Exa	amin	ation, Technic	al Exam	ination,	Stand	lard)	
6 Requirements on the Award of Credit Points											

 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
Usability of the Module Fachdidaktisches Projekt im Wahlpflichtbereich
Literature Siehe Teilmodule
Comment

Мо	dule nan	ne								
	Geor	netry (f	or Teac	hing Degrees)						
04-1	Aodule no. 14-10- 1091/de		Points 5 CP	Workload 150 h	Self-study 90		Duration 1 Semester		Frequency Every 2. semes	
	guage of man	Instruct	ion			on responsib . Dr. rer. nat.				
1	Course	s of the	Module							
	Course			name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	110-vu	Geomet	ry (for Teaching Degre	ees)	0		Lecture and Exercise		4
2	Euclide	•	•	es, triangles, circles perbolic or projectiv			conic sec	ctions,	Kepler's	laws.
3	Learning Outcomes Die Studierenden kennen und verstehen die elementargeometrischen Grundbegriffe und Methoden und können diese auf typische Fragestellungen anwenden.									
4	Requirements for Participation Linear Algebra (participation without certification of prerequisites is possible)									

5	Form of Examination Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: In der Regel erfolgt die Prüfung durch eine Klausur, bei geringer Teilnehmerzahl gegebenenfalls mündlich. Die Form der Prüfung wird anhand der voraussichtlichen Teilnehmerzahl in den ersten beiden Veranstaltungswochen festgelegt. Studienleistung: Sonderform (In der Regel erfolgreiche Bearbeitung eines Teils der Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.)
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	Mathematics: Teaching degrees
9	Literature
	I. Agricola, T. Friedrichs Elementargeometrie, Vieweg - Teubner G.A. Jennings: Modern geometry with applications, Springer
10	Comment

Module nam	ie									
Pract	Practical Training III: Mathematics in Schools									
Module no.	Credit Points	Workload	Self-study	Duration	Frequency					
04-10- 0093/de	5 CP	150 h	-	1 Semester	Every 2. semester					

Lan	guage of Instruct	tion	Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger					
Ger	man							
L	Courses of the	Module						
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week			
	04-00-0044-se	Practical training in schools II mathematics	for 0	Seminar	2			
2	Study Content observation, planning and reflexion of mathematics lessons as well as didactic and methodical concepts of learning environments, using didactic literature; discussion about a specialised didactic main focus. The students continue her portfolio from the practise phases I and II durin the traineeship, take part in a consultation offer and write a training period report.							
}	criterion-based	omes re able to observe lessons, to . They are able to create les ecialised didactic literature.						
	Requirements for Participation Foundations of Teaching and Learning Mathematics, Practise Phase I (participation without certification of prerequisites is possible) Form of Examination							
1	(participation w	vithout certification of prere		e I				
;	(participation v	vithout certification of prere		je l				
5	(participation w Form of Examin Final Module Ex	vithout certification of prere	equisites is possible)		tandard)			
5	(participation w Form of Examin Final Module Ex Modul	vithout certification of preren nation xamination: e Examination (Technical Ex e Examination (Study Exami	equisites is possible)	en Examination, S				
	(participation w Form of Examin Final Module Examin Modul Modul Passed Requirements	vithout certification of preren nation xamination: e Examination (Technical Ex e Examination (Study Exami	equisites is possible) amination, oral / writte nation, oral / written E	en Examination, S xamination, Passe	ed / Not			
5	(participation w Form of Examin Final Module Examin Modul Modul Passed Requirements Passing the Fac	vithout certification of prere nation xamination: e Examination (Technical Ex e Examination (Study Exami) on the Award of Credit Poir hprüfung; passing the Studio	equisites is possible) amination, oral / writte nation, oral / written E	en Examination, S xamination, Passe	ed / Not			
5	(participation w Form of Examin Final Module Example Modul Passed Requirements Passing the Fac Fachprüfung Grading Final Module Example Final Module Final Module Example Final Module Final Module Final Module Final Module Final Module Final Module Final Module	vithout certification of prere- nation xamination: e Examination (Technical Ex e Examination (Study Exami) on the Award of Credit Poir hprüfung; passing the Studio xamination: e Examination (Technical Ex	equisites is possible) amination, oral / written nation, oral / written E nts enleistung is a prerequi	en Examination, S xamination, Passe	ed / Not			
5	(participation w Form of Examin Final Module Examin • Modul • Modul Passed Requirements Passing the Fac Fachprüfung Grading Final Module Example • Modul Standa • Modul	vithout certification of prere- nation xamination: e Examination (Technical Ex e Examination (Study Exami) on the Award of Credit Poir hprüfung; passing the Studio xamination: e Examination (Technical Ex	equisites is possible) amination, oral / written nation, oral / written E nation, oral / written E nts enleistung is a prerequi	en Examination, S xamination, Passe site for taking the	ed / Not /eight: 100%			
5	(participation w Form of Examin Final Module Examin • Modul • Modul Passed Requirements Passing the Fac Fachprüfung Grading Final Module Example • Modul Standa • Modul	vithout certification of prere- nation xamination: e Examination (Technical Ex e Examination (Study Exami) on the Award of Credit Poir hprüfung; passing the Studio xamination: e Examination (Technical Ex rd) e Examination (Study Exami / Not Passed)	equisites is possible) amination, oral / written nation, oral / written E nation, oral / written E nts enleistung is a prerequi	en Examination, S xamination, Passe site for taking the	ed / Not			

9	Literature
	Barzel, B., Holzäpfel, L., Leuders, T., Streit, C. (2011). Scriptor Praxis - Mathematik: Mathematik unterrichten: Planen, durchführen, reflektieren: Buch mit Kopiervorlagen. Cornelsen Verlag Scriptor.
	Kratz, H. (2011). Wege zu einem kompetenzorientierten Mathematikunterricht – Ein Studien- und Praxisbuch für die Sekundarstufe. Kallmeyer – Klett, Seelze.
	Meyer, H. (2004). Praxisbuch: Was ist guter Unterricht? Mit didaktischer Landkarte. Cornelsen Verlag Scriptor.
10	Comment
	Verantwortlich: Frau Krüger (did)

Мо	dule nam	-								
04-3	dule no.	duction Credit F		el (online) Workload 0 h		study 0 h	Duration 1 Semes		Frequer Irregula	•
	guage of man	Instruct	ion			on responsib . Dr. phil. nat			ule	
1	Courses of the Module Course no. Course name		name		Workload ((CP)	Form Teact		Contact Hours per Week	
	04-10-0095-ku Introduction to Excel (online)			tion to Excel (online)		0 Co		Course	Course 0	
2		of excel f		n math-education, d (interactive) worksl	-	ms and randc	om numb	ers, fui	nctions a	nd sliders,
3	Learning Outcomes The participants acquire knowledge about the basic usage of excel and especially about functions and possibilites for usage in math-eduction. are able to use the software in addition to standard purposes for mathematical use cases and in class.									
4	Require	ements f	or Partio	cipation						
5		f Examir odule Ex		on:						

	Module Examination (Study Examination, Special Form, Passed / Not Passed)
6	Requirements on the Award of Credit Points Bestehen der Studienleistung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module Mathematics: Teaching degrees (only as "freiwillige zusätzliche Leistung")
9	Literature Moodle-Kurs online
10	Comment Verantwortlich: Frau Krüger (did)

Moc	lule nan	ne								
	Math	nematic	s I (for (Computer Science)					
Module no.Credit PointsWorkload04-10-9 CP270		Workload 270 h			Duration 1 Semes	•		ncy . semester		
Lang Gerr	-	Instruct	ion			on responsib . Dr. phil. nat				
1	Course	s of the	Module							
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	128-vu	Mathem	atics I (Computer Scie	ence)	0		Lectur Exercis		6
2	Study Content									
	 sets, relations, functions, groups, basic algebraic structures 									
	•	modular arithmetic, RSA algorithm for encrypting data								

	 finite dimensional vector spaces, linear maps and matrices, Gauss algorithm, determinants, eigenvalues
	basics: real and complex numbers
	sequences and convergence
3	Learning Outcomes
	Beherrschung der mengentheoretischen Sprechweise
	Vertrautheit mit grundlegenden algebraischen Strukturen und Grundbegriffen
	Verständnis der grundlegenden Begriffe der linearen Algebra
	Beherrschung der grundlegenden Algorithmen der linearen Algebra
	 Verständnis des Begriffs der reellen Zahlen und Beherrschung des Umgangs mit Grenzwertprozessen.
4	Requirements for Participation none
5	Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	 Module Examination (Study Examination, oral / written Examination, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam (30 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:

	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, oral / written Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module required
9	Literature lecture notes of course
10	Comment

Мос	dule nam	ne											
	Math	nematic	s II (for	Computer Sc	ience	e)							
Module no. 04-10- 0119/de		Credit Points 9 CP		Workload 2	270 h	Self-study 180 h		Duration 1 Semester		Frequency Every 2. semester			
					Person responsible for the Module Prof. Dr. phil. nat. Ulrich Kohlenbach								
1	Courses of the Module												
	Course no.		Course name			Workload (CP)		Form of Teaching		Contact Hours per Week			
	04-00-0087-vu		Mathematics II (Computer Science)			0		Lecture and Exercise		6			
2	Study Content • series and power series • standard functions • real functions and continuity • differential calculus, extremal value • exponential function and logarithm • integration: integrals, Fundamental								niques	of integ	gration		

	real functions of several variables
	Taylor and Fourier series
	 Ordinary differential equations, elementary techniques an examples, linear differental equations
3	Learning Outcomes
	• Beherrschung der wichtigsten Konvergenzkriterien für Reihen und ihrer Anwendung
	 Sicherheit im Umgang mit elementaren Funktionen wie Exponentialfunktion, Winkelfunktionen und Logarithmus
	Verständnis topologischer Grundbegriffe und ihrer Verwendung
	 Verständnis des Begriffs der Differenzierbarkeit und Beherrschung der Differentiationsregeln
	• Verständnis des Riemann-Integrals und Beherrschung einfacher Integrationstechniken
	Verständnis der Differentiation von Funktionen mehrerer reeller Variablen
	• Fähigkeit, Extremwertsaufgaben für Funktionen in mehreren Variablen zu lösen
	 Vertrautheit mit einfachen gewöhnlichen Differentialgleichungen und Lösungsmethoden dafür
4	Requirements for Participation Mathematik I
5	Form of Examination Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	 Module Examination (Study Examination, oral / written Examination, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam (30 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion

	of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.								
6	Requirements on the Award of Credit Points								
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, oral / written Examination, Weight: 0%, Passed / Not Passed) 								
8	Usability of the Module Pflicht								
9	 Literature Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch Mathematik für Ingenieure I/II, Teubner Meyberg/Vachenauer: Höhere Mathematik I/II, Springer-Verlag lecture notes of course 								
10	Comment								

Mo	dule nan	ne									
	Auto	mata, F	ormal L	anguages a	and De	cidabi	lity				
Module no. 04-10- 0120/de		Credit F	Points 5 CP			Self-study 105 h		Duration 1 Semester		Frequency Every 2. semester	
Language of Instruction					Person responsible for the Module Prof. Dr. rer. nat. Martin Otto						
1		ourses of the Module									
	Course no.		Course	name			Workload (CP) Form of Teaching		Contact Hours per Week	

	04-00-0091-vu	Automata, Formal Languages and Decidability	0	Lecture and Exercise	3			
2	Study Content introduction: transition systems, words, languages; basic mathematical methods and proof patterns; finite automata and regular languages; determinism and nondeterminism, closure properties and automata constructions, Kleene Theorem, Myhill-Nerode Theorem, pumping lemma; grammars and the Chomsky hierrachy, context-free languages, pumping lemma, CYK algorithm; models of computation: PDA and Turing machines; decidability and recursive enumerability in the Chomsky hierarchy							
3	\newline Hopcroft, Motw Komplexitätsthe \newline Wegener: Theo \newline	retische Informatik kurz gefass vani, Ullman: Einführung in die Au	utomatentheorie, forn hmenorientierte Einfü	ührung	und			
4	Requirements f	or Participation						
5	 Module Passed) Fachprüfung: Us only a small nur an oral exam (3 during the first the exam. Studienleistung of the homewo 	amination: e Examination (Technical Examin e Examination (Study Examinatio	n, oral / written Exam of a written test (90 m this case, the exam ca orm of the exam is take on the prospective nu dent successfully comp ortion of necessary as	ination, Passe in), except wh an be taken in en and commu mber of studen pletes a certair	d / Not en there are the form of inicated nts taking			
6		on the Award of Credit Points						
7	Grading Final Module Ex	amination:						

	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, oral / written Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
	Pflichtveranstaltung in Informatik-Studiengängen; Bestandteil des Moduls "Formale Grundlagen der Imformatik" im BSc Mathematik
9	Literature Schöning: Theoretische Informatik kurz gefasst \newline Hopcroft, Motwani, Ullman: Einführung in die Automatentheorie, formale Sprachen und Komplexitätstheorie \newline Wegener: Theoretische Informatik eine algorithmenorientierte Einführung \newline Skript (elektronisch unter www.mathematik.tu-darmstadt.de#47;~otto)
10	Comment durchgeführt als Teil einer (4+2) Veranstaltung

Мо	dule nan	ne								
	Prop	ositiona	al Logic	and Predicate Log	gic					
Module no. 04-10- 0121/de		Credit Points 5 CP		Workload 150 h	Self-study 105 h		Duration 1 Semester		Frequency Every 2. semester	
						on responsib . Dr. rer. nat.			ule	
1	Course	s of the	Module							
	Course no. Cou			se name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	090-vu	Proposit Logic	ional Logic and Predic	cate	0	Lecture and Exercise		3	
2	Study C	Content								
	functio a seque \newlir	Study Content syntax and semantics of propositional logic, functional completeness and normal forms, compactness, complete proof calculi: resolution and a sequent calculus; \newline syntax and semantics of first-order logic,								

	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, oral / written Examination, Weight: 0%, Passed / Not Passed)
7	Grading Final Module Examination:
6	Requirements on the Award of Credit Points
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
	Fachprüfung: Usually the exam is taken in form of a written test (90 min), except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam (30 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	 Module Examination (Technical Examination, oral / written Examination, Standard) Module Examination (Study Examination, oral / written Examination, Passed / Not Passed)
5	Form of Examination Final Module Examination:
4	Requirements for Participation Automaten, formale Sprachen und Entscheidbarkeit
3	Learning Outcomes Die Studierenden werden mit Inhalten und Methoden der mathematischen Logik und ihrer Rolle in der Informatik vertraut gemacht. Sie lernen die grundlegenden Begriffe und Resultate der Logik, insbesondere der Logik erster Stufe, kennen und anzuwenden. Sie beherrschen die grundsätzlichen mathematischen Methoden in der Behandlung von Syntax, Semantik und formalen Beweisen, sowie die Diskussion einfacher modelltheoretischer und algorithmischer Aspekte der behandelten logischen Systeme
	structures and assignments, normal forms, Skolemization, Herbrand theorem, compactness, complete proof calculi: (ground) resolution and a sequent calculus, Gödel's Completeness Theorem; undecidability of first-order logic; \newline optional: digressions on expressiveness and model checking

8	Usability of the Module Pflichtveranstaltung in Informatik-Studiengängen, Bestandteil des Moduls "Formale Grundlagen der Informatik" im BSc Mathematik
9	Literature Burris: Logic for Mathematics and Computer Science \newline Schöning: Logik für Informatiker \newline Boolos, Burgess, Jeffrey: Computability and Logic \newline Skript (2 Teile, elektronisch unter www.mathematik.tu-darmstadt.de#47;~otto)
10	Comment durchgeführt als Teil einer (4+2) Veranstaltung

Мо	dule nan	-									
Linear Algebra Module no. 04-10- 0124/de		•	Workload	rees) 70 h	Self-study		Duration 2 Semester		Frequency Every 2. semeste		
Language of Instruction German						on responsib . Dr. rer. nat.					
1	Courses of the Course no.		Module Course	name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	067-vu	Linear Algebra II (for Physics and Teaching Degrees (Mathematics)				0	Lecture and 3 Exercise		3	
	04-00-0	117-vu		lgebra I (for Phys g Degrees (Math						e and Se	3
2	Study Content vector spaces, linear mappings, matrices, change of coordinates, determinants, linear equations, eigenvalues, orthogonal and unitary transformations, symmetric hermitean, and normal matrices, quadratic forms, diagonalisation and normal forms										
3	Learning Outcomes Die Studierenden kennen Konzepte, Begriffe und Methoden der Linearen Algebra, insbesondere analytische Geometrie, Vektorräume und lineare Abbildungen, Matrizen, Eigenwerte und Orthogonalisierung. Sie sind befähigt, mathematische Lösungsstrategien im Hinblick auf die genannten Themenfelder mit den erlernten Methoden anzuwenden, mathematische Beweise										

	nachzuvollziehen und in einfachen Fällen zu führen.
4	Requirements for Participation
	none
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Written Exam, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: In der Regel erfolgt die Prüfung durch eine Klausur, bei geringer Teilnehmerzahl
	gegebenenfalls mündlich. Die Form der Prüfung wird anhand der voraussichtlichen
	Teilnehmerzahl in den ersten beiden Veranstaltungswochen festgelegt.
	Studienleistung: Sonderform (In der Regel erfolgreiche Bearbeitung eines Teils der
	Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung
	wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt
	gegeben.)
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	Module Examination (Technical Examination, Written Exam, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
	Mathematics: Teaching degrees
9	Literature
	K. Jänich: Lineare Algebra
	G.Fischer: Lineare Algebra
	P. Halmos: Finite-dimensional vector spaces
	G. Fischer: Lineare Algebra und Analytische Geometrie, Springer 2012
10	Comment

Мо	dule nam Semi		subject	-specififc didactics	5						
Module no. 04-10- Credit Points Workload			-		lf-study Duratio			•		e ncy 2. semester	
	guage of man	Instruc	tion					le for th Katja Kr		ıle	
L	Course	s of the	Module		,						
	Course	no.	Course	name		Workl	oad ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	039-se		for subject-specific : Algebra in schools		0			Semina	ar	2
	04-00-0	109-se	Seminar for subject-specific didactics: Online task training			0			Semina	ar	2
	04-00-0	112-se	Seminar for subject-specific didactics: Mathematical model with students			0			Seminar		2
	04-00-0	159-se		for subject-specific : Analysis in schools		0			Semina	ar	2
	04-00-0	160-se		for subject-specific Stochastics in schoo	ls	0			Semina	ar	2
	04-00-0	249-se	didactics	for subject-specific s: Digital media in atical lessons		0			Semina	ar	2
	04-00-0	291-se		for subject-specific 5: Long-term compete ment	nce	0			Semina	ar	2
	04-10-0	533-se		for subject-specific s: Geometry in school	S	0			Semina	ar	2
2	educati ``proble \item Geome curricul \item Algebra	ts are ei onal sta em-solvi itemize} try: gen um, use	ndards o ng". eral expe e of techr ruction of	nged thematically a r structured along t rience from teachin ology in teaching a numbers and treat ility; misconception	he co ng geo nd leo ment	ometry arning g t of equ	peten classe eome ations	ces ``arg s, spatial try, desig in secon	visuali gning m	`modelii zation al nath less chools, a	ng" and bility, ons rithmetic

	\item Analysis: introductory teaching of functions, study of functions, local growth rates and the notion of limits, the notion of Riemann integrals, applications of calculus suitable for high school teaching, misconceptions among students; high school curriculum, designing math lessons \end{itemize}
3	Learning Outcomes
	siehe Teilmodule
4	Requirements for Participation
	Pflichtmodul "Grundlagen des Lehrens und Lernens von Mathematik" abgeschlossen
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module
	Fachdidaktisches Seminar im Wahlpflichtbereich, K-Modul
9	Literature
	siehe Teilmodule
10	Comment

Mod	Module name								
	Seminar in Mathematics (alg), Bachelor								
Mod 04-1 0139	-	Credit Points 5 CP	Workload 150	Self-study	120 h	Duration 1 Semester	Frequency Every 2. semester		
Lang Gerr	-	Instruction		•	Person responsible for the Module Studiendekan*in des Fachbereichs 04				
1	Courses of the Module								

	1			1	1						
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-10-0350-se	Seminar in Mathematics (alg), Bachelor	0	Seminar	2						
2	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer.										
3	Students learn - give an oral ar - learn mathem	Learning Outcomes Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk									
4	-	Requirements for Participation recommended: depending on topic									
5	Studienleistung				pation in the						
6	Requirements of Passing the Stur	on the Award of Credit Points dienleistung									
7	Grading Course Examina • [04-10	ation: -0350-se] (Study Examination,	Presentation, Weight:	100%, Passed /	Not Passed)						
8	Usability of the B.Sc. Mathema										
9	Literature depending on t	opic									
10	Comment recommended:	Mathematics: Bachelor year 3	3 (alg)								

Mod	lule nam	ne								
	Semi	nar in N	/lathem	atics (alg), Bachel	or					
Mod 04-1 0139	-	Credit F	Points 5 CP	Workload 150 h	Self-study 120 h		Duration 1 Semester		Freque Every 2	ncy . semester
Language of Instruction English						on responsib iendekan*in				
1	Courses of the Module Course no. Course name		name		Workload ((CP)	Form of Teaching		Contact Hours per Week	
	04-10-03	351-se	Seminar Bachelor	in Mathematics (alg),		0		Semina	ar	2
2	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer.									
3	Student - give a - learn i	mathem	to Id writte atical ma	n presentation of an aterial on their own discussions about t						atical talk
4	-		or Partic dependi	ipation ng on topic						
5	Form of Examination Course Examination: • [04-10-0351-se] (Study Examination, Presentation, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate, active participation in the discussion about the other oral presentations.									
6	•		on the A dienleist	ward of Credit Poin ung	ts					
7	Grading Course	g Examina	ition:							

	• [04-10-0351-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik
9	Literature depending on topic
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

10100	dule nan	ne									
	Semi	nar in N	/lathem	atics (ana), Bache	lor						
Mo 04-1	dule no.	Credit Points Workload S		Self-s	study	Duration	n	Freque	ncy		
-	0/de		5 CP	150 h		120 h	1 Semest	ter	Every 2	. semester	
	guage of man	Instruct	ion			on responsib endekan*in					
1	Course	s of the I	Module		,						
	Course	no.	Course	name		Workload ((CP)	Form Teacl	-	Contact Hours per Week	
	04-10-0352-se Seminar Bachelor			in Mathematics (ana)),	0		Semina	ar	-	
2	•	ling on to	•	and topics can be of	otaine	d from the le	ecturer.				
3	Learnir	g Outco	mes								
3	Studen	Students learn to									
	- give an oral and written presentation of an intermediate-level mathematical topic										
	-			•	n inter	mediate-lev	el mather	natica	τορις		
	- learn	mathem	atical ma	aterial on their own							
	- learn	mathem	atical ma	•						atical talk	
4	- learn - engag Require	mathema e in prof ements f	atical ma essional or Partic	aterial on their own discussions about t cipation						atical talk	
4	- learn - engag Require	mathema e in prof ements f	atical ma essional or Partic	aterial on their own discussions about t						atical talk	
4	- learn - engag Require recomr	mathema e in prof ements f	atical ma essional or Partic depend	aterial on their own discussions about t cipation						atical talk	

	• [04-10-0352-se] (Study Examination, Presentation, Passed / Not Passed)
	Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar)
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Course Examination:
	• [04-10-0352-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik
9	Literature
	depending on topic
10	Comment
	Mathematics: Bachelor year 3 (ana)

Мос	dule nam	ne									
	Semi	nar in N	Nathem	atics (ana), Bache	lor						
04-1	dule no. LO- 0/en	Credit I	Points 5 CP	Workload 150 h		-study Duration 120 h 1 Semes				ncy . semester	
Lang	guage of	Instruct	ion			on responsib					
Eng	lish				Stud	iendekan*in	des Fach	bereicl	ns 04		
1	Courses of the Module										
	Course no. Course name					Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0353-se Seminar in Mathematics (ana Bachelor					0		Semina	ar	2	
2	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer.										
3		g Outco ts learn t									

	 give an oral and written presentation of an intermediate-level mathematical topic learn mathematical material on their own
	- engage in professional discussions about the content and presentation of a mathematical talk
4	Requirements for Participation
	recommended: depending on topic
5	Form of Examination
	Course Examination:
	• [04-10-0353-se] (Study Examination, Presentation, Passed / Not Passed)
	Studienleistung: Oral presentation, written expose where appropriate, active participation in the
	discussion about the other oral
	presentations.
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Course Examination:
	• [04-10-0353-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Bachelor year 3 (ana)
l	

Мос	Module name										
	Seminar in Mathematics (geo), Bachelor										
04-1	lodule no. A-10- L41/de 5 CP 1		50 h	Self-study 120 h		Duration 1 Semest			cy semester		
Lang Geri		Instruct	ion			Person responsible for the Module Studiendekan*in des Fachbereichs 04					
1	Course	s of the I	Module								
	Course no. Course name			Wo			Form Teach		Contact Hours		

		1		ŀ							
					per Week						
	04-10-0354-se	Seminar in Mathematics (geo), Bachelor	0	Seminar	2						
2	Study Content depending on t Details of the s	copic chedule and topics can be obta	ained from the	lecturer.							
3	- give an oral ai - learn mathem	Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk									
4	Requirements for Participation recommended: depending on topic										
5	 Form of Examination Course Examination: [04-10-0354-se] (Study Examination, Presentation, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar) 										
6	Requirements Passing the Stu	on the Award of Credit Points dienleistung									
7	Grading Course Examination: • [04-10-0354-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)										
8	Usability of the B.Sc. Mathema										
9	Literature depending on t	opic									
10	Comment recommended	: Mathematics: Bachelor year 3	B (geo)								

Module name

	Semi	nar in N	Nathem	atics (geo)	, Bache	lor					
04-2	dule no. 10- 1/en Credit Points Workload		150 h		study 120 h	Duration 1 Semester		Frequency Every 2. semester			
Lan Eng	guage of lish	Instruct	tion				on responsib iendekan*in				
1	Courses of the Course no.		Module Course	name			Workload (Norkload (CP) Form Teach		-	Contact Hours per Week
	04-10-0355-se Seminar in Mathematics (ge Bachelor),	0		Semina	ar	2
2	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer.										
3	Learning Outcomes Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk										
4	-		f or Partio dependi	-							
5	recommended: depending on topic Form of Examination Course Examination: • [04-10-0355-se] (Study Examination, Presentation, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate, active participation in the discussion about the other oral presentations.										
6	-		on the A dienleist	ward of Cre	dit Poin	ts					
7	Grading Course	Examina] (Study Exa	minatio	n, Pre	esentation, W	/eight: 10	0%, Pa	ussed / N	lot Passed)
8		ty of the athemat	e Module tik								
9	Literatu	ure									

	depending on topic
10	Comment
	recommended: Mathematics: Bachelor year 3 (geo)

Мо	dule nan	ne								
Seminar in Mathematics (log), BachModule no.04-10-0142/de5 CP150			Sel	Self-study Du				Frequency Every 2. semester		
	guage of man	Instruct	ion			son responsib diendekan*in				
1			Module Course	name		Workload (CP)		Form Teacł	-	Contact Hours per Week
	04-10-0	356-se	Seminar Bacheloi	in Mathematics (log), ')	,	0		Semina	ar	2
3	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer. Learning Outcomes Students learn to - give an oral and written presentation of an intermediate-level mathematical topic									
	 learn mathematical material on their own engage in professional discussions about the content and presentation of a mathematical talk 									
4			or Partio dependi							
5	recommended: depending on topic Form of Examination Course Examination: • [04-10-0356-se] (Study Examination, Presentation, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar)									
6	Require	ements o	on the A	ward of Credit Poin	ts					

	Passing the Studienleistung
7	Grading Course Examination: • [04-10-0356-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik
9	Literature depending on topic
10	Comment recommended: Mathematics: Bachelor year 3 (log)

Мос	dule nam		a - 11								
Module no. 04-10- 0142/en				atics (log), Bache Workload 150 h	Self	study Duration 120 h 1 Semes				uency y 2. semester	
Lang Engl	guage of ish	Instruct	tion			on responsib liendekan*in					
1		s of the						1_			
	Course	no.	Course	name		Workload ((CP)	Form Teacł	• •	Contact Hours per Week	
	04-10-0	357-se	Seminar Bacheloi	in Mathematics (log)	,	0	Seminar		2		
2	•	ling on t	•	and topics can be o	btaine	ed from the le	ecturer.				
3	Learning Outcomes Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk										
4	Require	ements	for Partio	cipation							

	recommended: depending on topic
5	Form of Examination
	Course Examination:
	• [04-10-0357-se] (Study Examination, Presentation, Passed / Not Passed)
	Studienleistung: Oral presentation, written expose where appropriate, active participation in the
	discussion about the other oral
	presentations.
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Course Examination:
	• [04-10-0357-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Bachelor year 3 (log)

Mo	Module name										
	Semi	nar in N	Nathem	atics (num), Bach	elor						
04-2	Module no.Credit PointsWorkload04-10-5 CP1500143/de5 CP150					-study Duration 120 h 1 Semester		Frequency Every 2. semester			
	Language of Instruction German 1 Courses of the Module				Person responsible for the Module Studiendekan*in des Fachbereichs 04						
	Course	Course no. Course		name	Workload (CP) Form of Teaching			Contact Hours per Week			
	04-10-0	04-10-0358-se Seminar in Mathematics (num Bachelor				0		Semina	ar	2	

2	Study Content depending on topic
	Die Details zum Ablauf und den Themen können bei den Dozent*innen erfragt werden.
3	Learning Outcomes
	Students learn to
	- give an oral and written presentation of an intermediate-level mathematical topic
	- learn mathematical material on their own
	- engage in professional discussions about the content and presentation of a mathematical talk
4	Requirements for Participation
	recommended: depending on topic
5	Form of Examination
	Course Examination:
	• [04-10-0358-se] (Study Examination, Presentation, Passed / Not Passed)
	Studienleistung: Oral presentation, written expose where appropriate (Details will be
	announced at the beginning of the seminar)
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Course Examination:
	• [04-10-0358-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Bachelor year 3 (num)

Module nan	Module name											
Semi	Seminar in Mathematics (num), Bachelor											
Module no.	Credit Points	Workload		Self-study		Duration	Frequency					
04-10- 0143/en	5 CP	1	.50 h		120 h	1 Semester	Every 2. semester					

Lang	guage of Instruc	tion	Person responsible for the Module								
Engl	ish		Stu	diendekan*in des I	Fachbereichs 04						
1	Courses of the	Module									
	Course no.	Course name		Workload (CP)	Form of Teaching	Contact Hours per Week					
	04-10-0359-se	Seminar in Mathematics (nun Bachelor	n),	0	Seminar	2					
2	Study Content depending on t Details of the s		btain	ed from the lectur	er.						
3	Students learn - give an oral a - learn mathem	Learning Outcomes Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk									
4	Requirements for Participation recommended: depending on topic										
5	Studienleistung discussion abo	ation:)-0359-se] (Study Examinatio g: Oral presentation, written ut the other oral				ipation in the					
6	presentations. Requirements Passing the Stu	on the Award of Credit Poin	nts								
7	Grading Course Examination:										
8	Usability of the B.Sc. Mathema										
9	Literature depending on t	topic									
10	Comment recommended	: Mathematics: Bachelor yea	r 3 (r	num)							

Мо	dule nan	ne									
	Semi	nar in N	/lathem	atics (opt), Bache	lor				1		
04-	dule no. 10- 4/de	Credit F	Points 5 CP	Workload 150 h		f-study Duratio		•		ncy . semester	
Lan	guage of	Instruct	ion			on responsib					
1	Course	s of the	Module		ļ						
	Course no.		Course	urse name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0	360-se	Seminar Bacheloi	in Mathematics (opt)	,	0		Seminar		2	
2	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer.										
3	Learning Outcomes Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk										
4	-		or Partio dependi	cipation ng on topic							
5	Form of Examination Course Examination: • [04-10-0360-se] (Study Examination, Presentation, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar)										
6	-		on the A dienleist	ward of Credit Poin	ts						
7	Gradin Course	g Examina	ation:								

	• [04-10-0360-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik
9	Literature depending on topic
10	Comment recommended: Mathematics: Bachelor year 3 (opt)

Мо	dule nan	ne								
	Semi	nar in N	Aathem	atics (opt), Bache	lor					
04-	dule no. 10- 4/en	Credit F	Points 5 CP	Workload 150 h	Self-study 120 h		Duration 1 Semester		Frequency Every 2. semeste	
Lan	Language of Instruction English					on responsib				
1		s of the	Module		ļ					
	Course	ourse no. Course		name		Workload (CP)		Form of Teaching		Contact Hours per Week
			Seminar Bachelo	in Mathematics (opt)	opt), 0			Semina	ar	2
2	depend	Content ling on to ails zum	•	und den Themen kö	nnen	bei den Doze	ent*innen	erfrag	gt werde	n.
3	Learning Outcomes Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk									
4	-		f or Parti o dependi	cipation ing on topic						
5		f Examir Examina								

ntation, Passed / Not Passed)
where appropriate, active participation in the
ntation, Weight: 100%, Passed / Not Passed)

	Semi	nar in I	Mathem	atics (sto), Bachel	or				
Module no. 04-10- 0145/de		Points 5 CP	Workload 150 h	Self-study 120		Duration L Semester	Frequency Every 2. semester		
	guage of man	Instruc	tion		Person respons Studiendekan*				
1	Course	s of the	Module						
	Course	no.	Course	name	Workload	(CF	P) Form Teac		Contact Hours per Week
	04-10-0	362-se	Seminar Bacheloi	in Mathematics (sto)	0		Semin	ar	2
2	Study C depend Details	ling on t	•	and topics can be of	otained from the	e lec	turer.		

3	Learning Outcomes
	Students learn to - give an oral and written presentation of an intermediate-level mathematical topic - learn mathematical material on their own
	- engage in professional discussions about the content and presentation of a mathematical talk
4	Requirements for Participation recommended: depending on topic
5	Form of Examination Course Examination:
	• [04-10-0362-se] (Study Examination, Presentation, Passed / Not Passed)
	Studienleistung: Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar)
6	Requirements on the Award of Credit Points Passing the Studienleistung
7	Grading Course Examination: • [04-10-0362-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik
9	Literature depending on topic
10	Comment recommended: Mathematics: Bachelor year 3 (sto)

Мос	Module name										
Seminar in Mathematics (sto), Bachelor											
	dule no.	Credit Points		Workload		Self-study Duration		n	Frequency		
04-1 014	10- 5/en				150 h		120 h	1 Semes	ter	Every 2. seme	
Lang	guage of	Instruct	ion			Pers	on responsib	le for the	Modul	le	
Engl	lish					Studi	endekan*in	des Fach	bereich	s 04	
1	Course	s of the I	Module								
	Course	se no. Course name					Workload (CP)	Form o	of	Contact

r		1		-1								
				Teaching	Hours per Week							
	04-10-0363-se	Seminar in Mathematics (sto), Bachelor	0	Seminar	2							
2	Study Content											
	depending on t Details of the so	opic chedule and topics can be obtair	ed from the lecturer.									
3	Learning Outco											
	Students learn t		ormodiato loval math	maticaltania								
	-	nd written presentation of an int atical material on their own										
	- engage in professional discussions about the content and presentation of a mathematical talk											
4	Requirements	Requirements for Participation										
	recommended:	depending on topic										
5	Form of Examir	nation										
	Course Examina	ation:										
	• [04-10-	-0363-se] (Study Examination, P	resentation, Passed / I	Not Passed)								
	Studienleistung	: Oral presentation, written exp	ose where appropriate	, active partici	pation in the							
		it the other oral										
	presentations.											
6	Requirements	on the Award of Credit Points										
	Passing the Stu	dienleistung										
7	Grading											
	Course Examina	ation:										
	• [04-10-	-0363-se] (Study Examination, P	resentation, Weight: 1	00%, Passed /	Not Passed)							
8	Usability of the	Module										
	B.Sc. Mathemat	tik										
9	Literature											
	depending on t	opic										
10	Comment											
	recommended:	Mathematics: Bachelor year 3 (sto)									

Mo	dule nam	ne									
	Lie A	lgebras									
Mo	dule no.	Credit F	Points	Workload	Self-s	tudy	Duration	า	Freque	ency	
04-2	10-0147		9 CP	270 h	n 180 h 1 Semester Irregular						
	guage of		ion			n responsib					
	man and				Prof.	Dr. rer. nat.	Nils Sche	ithaue	r		
1		s of the l						<u> </u>			
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0	022-vu	Lie Alget	bras	C	D		Lecture Exercis		6	
	algebra	s, repres	sentation	, Cartan subalgebra n theory of semisim ody algebras		•		•		•	
3	Learning Outcomes The students know the structure and representation theory of semisimple Lie algebras.										
4	-		or Partic Algebra	cipation							
5		f Examir odule Ex	ation caminatio	on:							
	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)										
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an or exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.							m of an oral ne first two			
6	•		on the Av	ward of Credit Poin	its						
7	Gradinរ្ Final M		aminatio	on:							

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Serre: Complex semisimple Lie algebras, Springer Humphreys: Introduction to Lie algebras and representation theory, Springer Bourbaki: Lie groups and Lie algebras, Springer Carter: Lie algebras of finite and affine type, Cambridge University Press Kac: Infinite dimensional Lie algebras, Cambridge University Press
10	Comment recommended: Mathematics: Master (alg)

Мос	dule nan	ne										
	Algel	braic Nu	umber T	heory			•		-			
Мос	dule no.	Credit F	Points	Workload	Self	-study	Duration	n	Frequen	су		
04-1	LO-0149		9 CP	270	h	180 h	1 Semes	ter	Irregular	-		
Lang	guage of	Instruct	ion		Pers	son responsib	le for the	for the Module				
Geri	man and	English			Pro	f. Dr. rer. nat.	Nils Sche	ithaue	r			
1	Courses of the Module											
	Course no.		Course	rse name		Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-00-0181-vu		Algebrai	gebraic Number Theory		0		Lecture and Exercise		6		
2	group,	aic intege extensio	ns of De	ekind rings, ideals dekind rings, ram troduction to clas	ificatio	n, orders, pos			• •			
3	The stu	Learning Outcomes The students understand the basic notions and techniques of algebraic number theory and can apply them to typical questions.										
4		Requirements for Participation recommended: Algebra										

5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Neukirch: Algebraic number theory, Springer Lang: Algebraic number theory, Addison-Wesley Milne: Algebraic number theory, course notes Zagier: Zetafunktionen und quadratische Zahlkörper, Springer Cassels, Fröhlich: Algebraic number theory, Thompson
10	Comment recommended: Mathematics: Master (alg)

Mo	dule nan	ne										
	Spec	tral The	ory									
Module no.Credit Points04-10-5 CF0150/de		Points 5 CP	Workload	150 h	•		Duration 1 Semester		Frequency Every 2. semester			
	guage of man	Instruct	ion		Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber							
1	Course	s of the I	Module									
	Course no. Course name					Form Teach		Contact Hours				

					per
	04-00-0182-vu	Spectral Theory	0	Lecture and	Week 3
			0	Exercise	
2	functional calcu	algebras, spectral theory in Ilus, positivity in C*-algebras esentations of C*-algebras	as, approximating u		
3	algebras and th and to use thes the homomorpl are able to dem	mes this course are enabled to eir representations, to dev e results to classify commu- hy theorem and the impor nonstrate the existence of a e celebrated representatio	velop the spectral th utative C*-algebras. tance of positivity fo (in a sense) sufficien	eory of commutative C They understand the m or general C*-algebras. htly many states and to	*-algebras neaning of Finally, they employ this
4	Requirements f Functional Anal	for Participation ysis			
5					
6	Requirements o	on the Award of Credit Po	ints		
7	Standar	e Examination (Technical E ^r d) e Examination (Study Exam			
8		Module .Math(bilingual), B.Sc.WiN ctive course, M.Sc.Math: s			
9	Literature D. Werner: Fun	ktionalanalysis, J.B. Conwa	y: A Course in Funct	tional Analysis.	
10	Comment				

Mo	dule nan	ne									
Мо	Com dule no.	plexity ⁻ Credit F	<u>·</u>	Workload	Solf	-study	Duratior	<u> </u>	Freque		
04-: 019	10- 1/en	Creditr	6 CP	180		-	1 Semes		-	2. semester	
Lan Eng	guage of lish	Instruct	ion		Person responsible for the Module Dr. rer. nat. Kord Eickmeyer						
1	Course	s of the	Module								
	Course	Course no.		Course name		Workload ((CP)	Form of Teaching		Contact Hours per Week	
	04-00-0	267-vu	Complex	ity Theory		0		Lecture Exercis		4	
	comple	xity and	circuits,	yi Theorem; L, NL a P-completeness; a polynomial hiera	ryptog	•			d UP;		
3	Nachde Anliege Bedeut von ein Komple	en und M ung und em Algo exitätskla	erende c lethoder die Unte rithmus assen erk	liese Veranstaltun der klassischen K erschiede des asyn und von einem Pr lären und bewerte ispielprobleme in	omple nptotis oblem. en; sov	xitätstheorie schen Ressour Sie können c vie vergleiche	wiederge rcenbeda lie wesen	ben. Si rfs "Ze tlicher	ie erker it" und j	inen die "Speicher"	
4	ein Pro	seminar		Eipation Logik und Logik un ung in die mathem		-	Formale (Grundl	agen de	er.	
5		Form of Examination Final Module Examination:									
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)										
	•				inatio	n, Study Exan	nination,	Passed	d / Not I	Passed)	

6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc.Math: Wahlpflichtbereich M.Sc.Math: Ergänzungsbereich
9	Literature Uwe Schöning: Theoretische Informatik kurzgefasst; Garey#47;Johnson: Computers and Intractability Papadimitriou: Computational Complexity
10	Comment

Mod	lule nam	ne								
	Cate	gorical I	Logic							
Module no.Credit PointsWorkload04-10-5 CP0193/en		Workload 150 h			Duration 1 Semester		Frequency Irregular			
Language of InstructionPerson responsible for Prof. Dr. rer. nat. The										
1	Course	s of the	Module							
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0193-vu Categorical Logic					0		Lecture Exercis		3
2	Study Content cartesian closed categories, elementary topos, internal logic, (pre)sheaves									
3		g Outco								
	Studen	ts know	how to i	nterpret various log	ic cal	culi in approp	oriate cate	egories	s like pres	sheaves

	etc. This way they develop an understanding of intuitionistic logic.
4	Requirements for Participation
	recommended: Introduction to Mathematical Logic
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a
	small number of potential participants. In this case, the exam can be taken in the form of an oral
	exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
	B.SC Mathematik, M.SC. Mathematik, M.SC. Mathematics
9	Literature
	Lecture notes provided online
10	Comment
	recommended: Mathematics: Master (log)

Мос	dule nan	ne									
	Cate	gory The	eory								
Moc 04-1	dule no. 10-	D. Credit Points V 5 CP		Workload						Frequency Irregular	
0194	4/en			150			105 h	105 h 1 Semester			
Lang	guage of	Instruct	ion			Perso	on responsib	le for the	e Modul	le	
Engl	ish					Prof.	Dr. rer. nat.	Thomas S	Streiche	er	
1	Course	s of the I	Module								
	Course	Course no. Course name					Workload (CP)	Form o	of	Contact

				Teaching	Hours per Week				
	04-00-0194-vu	Category Theory	0	Lecture and Exercise	3				
2	Study Content categories, func	tors, Yoneda lemma, limits	and colimits, adj	oints monads					
3	how to use the	mes rmulate basic notions of al Yoneda lemma, the notion s various manifestations.			-				
4	-	or Participation Introduction to Mathemat	ical Logic						
5	Final Module Ex Module min, Sta Fachprüfung: Us small number o exam. The decis	 Form of Examination inal Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a mall number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two veeks of the lecture, based on the prospective number of students taking the exam. 							
6	Requirements of Passing the Facl		nts						
7	Grading Final Module Ex • Module Standar	e Examination (Technical Ex	xamination, oral /	written Examination, Wo	eight: 100%,				
8	Usability of the B.Sc Mathemati	Module k, M.Sc. Mathematik, M.Sc	c. Mathematics						
9	Literature Lecture notes p	rovided online							
10	Comment recommended:	Mathematics: Master (log)							

Мо	dule nam	ne								
	Math	ematic	al Statis	tics					-	
04-:	dule no. 10- 9/de	Credit F	Points 9 CP	Workload 270 h	Self-s	-	Duration 1 Semes		Freque Irregul	-
Lan	guage of	Instruct	ion			on responsib Dr. rer. nat.			ule	
1 1	man	s of the	Madula		Dr. rer. nat.	wiichael	Konier			
1	Course		Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	073-vu	Mathem	atical Statistics	(0		Lecture Exercis		6
2		ion of di		ns, VC theory, dens nparametric regres	•	imation, poi	nt estima	ation, s	tatistica	al tests,
3	Student - under - develo - are ab	stand ar op an ad le to ext ements f	id are ab vanced lo end thei	le to apply the notice evel of understandi r knowledge in this ipation ity Theory	ng of r				in the co	ourse
5	Form o	f Examir odule E>	nation kamination e Examin		aminat	tion, oral / w	ritten Ex	aminat	tion, Du	ration 90
	small n exam. T	umber o The decis	f potenti sion abou	e exam is taken in f al participants. In t It the form of the e sed on the prospec	his cas xam is	e, the exam taken and c	can be ta ommunio	iken in cated c	the for luring th	m of an oral ne first two
6	-		on the A v hprüfunរ្ខ	ward of Credit Poin	its					
7	Gradin	3								

	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Witting: Mathematische Statistik I
10	Comment recommended: Mathematics: Master (sto)

Mo	dule nan	ne								
	Non-	Life Ins	urance	Mathematics						
04-2	dule no. 10- 0/de	Credit F	Points 5 CP	Workload 150		-study 105 h	Duration 1 Semes		Freque Irregula	•
Language of Instruction					on responsib					
1	-	s of the	Module			. Di. iei. ilat.	wiichaei	KUIIIEI		
Ŧ	Courses of the M Course no.		Course	name		Workload (CP)	Form Teact	-	Contact Hours per Week
	04-00-0197-vu Non-Life			Insurance Mathem	atics	0		Lectur		3
2		cal meth		calculation of the ressed in the lectu		m of a non-lif	^f e insurar	nce. Po	ssible so	cietal
3	Studen - under - develo mather - are ab Studen	stand ar op an int natics ole to ext ts are ab	id are ab ermedia end the le to cor	le to apply the no te level of unders ir knowledge in th ntextualize subject ethically and respo	tanding is field t matte	g of the meth er within the s	ods empl	oyed ii	n non-life	e insurance

4	Requirements for Participation recommended: Probability Theory, Mathematical Statistics
5	Form of Examination Final Module Examination:
	 Module Examination. Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Mack: Schadenversicherungsmathematik
10	Comment recommended: Mathematics: Master (sto)

Мо	dule nam	ne							
	Nons	mooth C	Optimiz	ation					
Мо	dule no.	Credit Po	oints	Workload		Self-study	Duration	Frequen	су
04-:	10-0202		5 CP		150 h	105 h	1 Semester	Irregular	-
Lan	guage of	Instructio	on			Person responsib	le for the Mod	ule	
Ger	man and	English				Prof. Dr. rer. nat.	Stefan Ulbrich		
1	Course	s of the M	Iodule						
	Course	no.	Course	name		Workload ((CP) Form Teac	•••	Contact Hours per Week

	04-00-0199-vu Nonsmooth Optimization 0 Lecture and 3 Exercise 3
2	Study Content Nonsmooth optimization: Examples, subdifferential of convex functions, subgradient method, cutting plane method, epsilon-subdifferential, bundle methods, applications; Nonsmooth equations: Examples, generalized Newton methods, generalized differentials, semismoothness, semismooth Newton methods, applications
3	Learning Outcomes Students • know the basic theory and methods for non-smooth optimization problems. • knows the specific difficulties and the resulting concepts for non-smooth problems. • know applications and can solve these. • are proficient in methods for the solution of non-smooth equations. • know relvant applications for non-smooth equations and can solve these.
4	Requirements for Participation recommended: Introduction to Optimization
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module VI.Sc. Mathematik, M.Sc. Mathematics
9	L iterature C. Geiger, C. Kanzow: Theorie und Numerik restringierter Optimierungsaufgaben W. Alt: Numerische Verfahren der konvexen, nichtglatten Optimierung I.F. Bonnans, J. Gilbert, C. Lemaréchal, C.A. Sagastizábel: Numerical Optimization

10	Comment
	recommended: Mathematics: Master (opt) offered alternatingly with Game Theory and Interior Point Methods for Convex Optimization; recommended for Studienrichtung Mathematik in B.Sc. Mathematik

	Inter	ior Poin	t Meth	ods for Convex O	otimi	zation	Γ			
Мо	dule no.	Credit F		Workload		study	Duratio		Freque	•
04-	10-0203		5 CP	150 h		105 h	1 Semes	ter	Irregula	ar
Lan	guage of	Instruct	ion			on responsib			ule	
Ger	man and	English			Prof.	. Dr. rer. nat.	Stefan U	lbrich		
1	Courses	s of the	Module							
	Course	no.	Course	name		Workload (0	CP)	Form Teacł	-	Contact Hours per Week
	04-00-02	200-vu	Interior Optimiza	Point Methods for Co ation	nvex	0		Lectur Exercis		3
	methoo methoo optimiz	ction: Ex ls for line l, conver ation: se	ear optir gence th lfconcor	classical barrier me nization: primal pat neory, complexity; i dant barrier funtion	h follo nterio ns, sel	owing metho or point meth	d, primal ods for g	-dual p eneral	oath follo convex	owing
	Introdu methoc methoc optimiz	ction: Ex ls for line l, conver ation: se	ear optir gence th lfconcor	nization: primal pat neory, complexity; i	h follo nterio ns, sel	owing metho or point meth	d, primal ods for g	-dual p eneral	oath follo convex	owing
3	Introdu method optimiz step me Learnin Student - know - are fat optimiz	ction: Ex ls for line ation: se ethod, lo g Outco ts and und miliar wi ation pre	ear optir gence th elfconcor ng step mes erstand th the ge oblems b	nization: primal pat neory, complexity; i dant barrier funtion	h follo nterio ns, sel ns cepts v to cc dant l	owing metho or point meth lfconcordanc of modern in onstruct inter barrier functi	d, primal ods for g e and Ne terior-pc ior-point	-dual p eneral wton's	thods	owing d, short
3	Introdu methoc optimiz step me Learnin Student - know - are fai optimiz - know Require	ction: Ex Is for line ation: se ethod, lo g Outco ts and und miliar wi ation pre applicati	ear optir gence the elfconcor ing step mes erstand th the ge oblems to ion scena for Partic	nization: primal pat neory, complexity; in dant barrier funtion method, application the theory and cont eneral methodology based on selfconcor arios of the general	h follo nterio ns, sel ns cepts v to co dant l theor	owing metho or point meth lfconcordanc of modern in onstruct inter barrier functi	d, primal ods for g e and Ne terior-pc ior-point	-dual p eneral wton's	thods	owing d, short

	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	S.J. Wright: Primal-Dual Interior Point Methods;
	Y. Nesterov, A. Nemirovski: Interior-Point Polynomial Algorithms in Convex Programming;
	J. Renegar: A Mathematical View of Interior-Point Methods in Convex Optimization;
	Y. Ye: Interior Point Algorithms: Theory and Analysis; Wiley- Interscience
10	Comment
	recommended: Mathematics: Master (opt)
	offered alternatingly with Game Theory and Nonsmooth Optimization; recommended for
	Studienrichtung Mathematik in B.Sc. Mathematik

Mo	dule nam	ne								
	Cate	gory Th	eory							
04-1	dule no. LO- 0/de	Credit I	Points 5 CP	Workload	150 h	study 105 h	Duration 1 Semes	-	Frequer Every 2.	semester
	Language of Instruction German 1 Courses of the Module					on responsib Dr. rer. nat.				
	Course	Course no. Course name			Workload ((. ,		of ling	Contact Hours per Week	
	04-00-03	210-vu	Category	y Theory		0		Lecture Exercis		3

2	Study Content categories, functors, Yoneda lemma, limits and colimits, adjoints monads
3	Learning Outcomes getting familiar with the basic notions and techniques together with their applications in algebra, topology etc.
4	Requirements for Participation Einf. in die Logik
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
9	Literature Skript online erhältlich
10	Comment

Module name									
Cate	Categorical Logic								
Module no.	Credit Points	Workload	Self-study		Duration	Frequency			
04-10- 0211/de	5 CP	150	-	105 h	1 Semester	Every 2. semester			

Lang	guage of Instruc	tion	Pers	on responsible for	the Module	
Geri	man		Prof	. Dr. rer. nat. Thom	nas Streicher	
1	Courses of the	Module				
	Course no.	Course name		Workload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0211-vu	Categorical Logic		0	Lecture and Exercise	3
2	Study Content cartesian close	d categories, elementary to	pos, ir	iternal logic, (pre)s	heaves	
3	categories diffe	omes e developed an understand erent from Set. In particular, ituitionistic logic.	-	-		-
4	Requirements Einf. in die Logi	for Participation ik				
5						
6	Requirements	on the Award of Credit Poin	nts			
7	Standa	le Examination (Technical Ex rd) le Examination (Study Exam				
8	Usability of the	e Module				
9	Literature Skript online er	rhältlich				
10	Comment					

	Mod	el Theo	ry						
04-	dule no. 10- L2/en	Credit F	Points 5 CP	Workload 150 h				Freque Irregula	-
	iguage of glish	Instruct	ion		Person responsib Prof. Dr. rer. nat.			ıle	
1	Courses of the Module				<u> </u>				
	Course	no.	Course	name	Workload ((-	Form Teach	-	Contact Hours per Week
	04-00-0	212-vu	Model T	heory	0		ecture xercis		3
	types a	nu satur	ation pro	operties; countable	models and catego	oricity; Fraï	ïssé lir	mits and	orphy; 1 0-1-laws
3	Learnin Student theory model t	g Outco ts unders treated i theory o	mes stand an n the co f first-ore	d are able to apply urse. They have dev der logic, which ena	the notions, metho veloped an advanc ables them to exter	ods and res	sults c unde	of classio rstandir	d 0-1-laws cal model
3	Learnin Studen theory model t to relat	g Outco ts unders treated i theory of e it to po ements f	mes stand an n the co f first-ord otential a or Partic	d are able to apply urse. They have dev der logic, which ena application areas ur	the notions, metho veloped an advanc ables them to exten ader supervision.	ods and res	sults c unde	of classio rstandir	d 0-1-laws cal model
	Learnin Student theory model t to relat Require recomn Form o Final M Fachpro small n exam. T	g Outco ts unders treated i cheory of e it to po ements f mended: f Examin odule Ex Module min, Sta úfung: Us umber o The decis	mes stand an n the co f first-ord otential a or Partic Introduc nation aminatic e Examin andard) sually the f potenti	d are able to apply urse. They have dev der logic, which ena application areas ur cipation ction to Mathematic	the notions, methor veloped an advance ables them to extended supervision. cal Logic amination, oral / wo orm of a written te his case, the exam xam is taken and c	ods and res ed level of nd their kno vritten Exar est, except can be take	sults c unde owlec minat when en in ated d	of classic rstandir dge in th dge in th n there a the forn luring th	al model ng of the his field and ration 60 hire only a n of an oral

	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Cori/Lascar: Mathematical Logik Chang/Keisler: Model Theory Hodges: Model Theory Hodges: A Shorter Model Theory Marker: Model Theory, an Introduction Rothmaler: ModelItheorie Poizat: A Course in Model Theory
10	Comment recommended: Mathematics: Master (log) Due to content overlap, this course cannot be combined with Classical and Non-Classical Model Theory.

Мос	Module name									
	PDE II.B Navier-Stokes-Equations									
Мос	dule no.	Credit I	Points	Workload	Self-	study	Duratior	1	Frequer	ncy
04-1	04-10-0213 5 CP 150					105 h	1 Semes	ter	Irregula	r
Lang	guage of	Instruct	tion		Pers	on responsib	le for the	Modu	ıle	
Geri	man and	English			Prof.	Dr. rer. nat.	Matthias	Hiebe	r	
1	Course	s of the	Module							
	Course no		Course	name		Workload ((CP)	Form Teacł	•.	Contact Hours per Week
	04-00-03	213-vu	PDE II.B	Navier-Stokes-Equati	ons	0		Lecture Exercis		3
2	Study C	Content								
	2 Study Content Development and analytical treatment of the fundamental equations of fluid dynamics, divergence problems, methods for the solution using evolution equations and the Stokes semi- group, Kato-Iteration, weak solutions.									

3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course
	- develop an advanced level of understanding of the Navier-Stokes equations
	- are able to extend their knowledge in this field
	- are able perform supervised research in this field
4	Requirements for Participation recommended: Functional Analysis, Partial Differential Equations I
5	Form of Examination Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Galdi: An introduction to the mathematical theory of the Navier-Stokes equations. Springer Verlag
	Sohr: The Navier-Stokes equations. An elementary functional analytic approach. Birkhäuser
	Verlag Temam: Navier-Stokes equations. Theory and numerical analysis. North- Holland Publishing Co.
10	Comment
	recommended: Mathematics: Master (ana) Builds on "Partial Differential Equations I".
	Upon approval, contents of two PDE II.X-courses may replace "Partial Differential Equations II" and can be combined with the content from "Partial Differential Equations I" as an "Advanced Course in Analysis".
	Combinations of two or more PDE II.X-courses as additional courses require approval, too.

Мо	dule nam	ne								
	Harm	nonic Ar	nalysis							
04-2	dule no. 10- .6/de	Credit F	Points 5 CP	Workload 150 h	Self-st	-	Duration 1 Semes		Freque Every 2	e ncy 2. semester
	guage of man	Instruct	ion			responsib Pr. rer. nat.				
1	Course	s of the l	Module		- ·					
	Course	no.	Course	name	v	Vorkload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	216-vu	Harmoni	c Anylsis	0			Lecture Exercis		3
2	Study C Theory		outions,	interpolation of fur	nction sp	baces, singu	ılar integ	rals.		
3	Student the cou function their kr	rse. The ns on Eu nowledge	stand an y develo		l of und	erstanding	of interp	olatior	n theory	for
-	-		tegratio	-						
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) 						ard)			
6	Require	ements o	on the Av	ward of Credit Poin	nts					
7	Gradinı Final M	odule Ex		on: ation (Technical Ex	aminati	on, Technic	al Exami	nation,	, Weight	t: 100%,
8	Usabilit	ty of the	Module							

	Specialisation area Master Mathematics.
9	Literature Grafakos: Classical Fourier Analysis
10	Comment

	Alge	oraic Ge	eometry	,					
Мо	dule no.			Workload	Self-study	Duratior	า	Frequency	
04-	10-0222		9 CP	270 h	180 h	1 Semes	ter	Irregula	ar
Lan	guage of	Instruct	ion		Person responsit	le for the	e Modu	ule	
Ger	man and	English			Prof. Dr. rer. nat.	Torsten E	Burkha	rd Wed	horn
1	Course	s of the I	Module						
	Course	no.	Course	name	Workload (CP)	Form Teacł		Contact Hours per Week
	04-00-0	221-vu	Algebrai	c Geometry	0		Lectur Exercis		6
2	Study C Varietie		hemes, ı	norphisms, dimens	ion, singularities				
3	Studen		stand ba	sic notions and met I algebraic problem	•			re able 1	to study
4	-	e ments f nended:	or Partic Algebra	ipation					
5	Final M	Module min, Sta	kaminatio e Examin andard)	on: ation (Technical Ex e exam is taken in f					
	small n exam. ⊺	umber o The decis	f potenti sion abou	al participants. In the form of the e sed on the prospec	his case, the exam xam is taken and o	can be ta communic	iken in cated c	the fori luring th	m of an ora

6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature K. Hulek, Elementary algebraic geometry, AMS R. Hartshorne: Algebraic geometry, Springer I. R. Shafarevich: Basic algebraic geometry 1,2 U. Görtz, T. Wedhorn: Algebraic Geometry, Vieweg
10	Comment recommended: Mathematics: Master (alg)

Mod	lule nam	ne									
	Auto	morphi	ic Forms	;							
Mod 04-1 0224		Credit I	Points 5 CP	Workload	150 h		study 105 h	Duratior 1 Semes	-	Freque Every 2	ncy . semester
Lang Gerr		Instruct	tion				on responsib Dr. rer. nat.				
1	Course	s of the	Module			·					
	Course no. Course			name			Workload (C	CP)	Form Teacł	•••	Contact Hours per Week
	04-00-0	223-vu	Automo	rphic Forms			0		Lectur Exercis		3
2	Study C	Content									
				odular forms, ns, automorp					cke		
3	Learnin	ng Outco	mes								
	Die Stu	denten	verstehe	n fortgeschrit	ttene T	echni	ken der Zahle	entheorie	wie		

	automorphe Formen und L-Funktionen und können diese anwenden.
4	Requirements for Participation
	Einführung in die Algebra,
	Complex Analysis
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Medule Eveningtion (Technical Eveningtion, Technical Eveningtion, Meight: 100%
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module
	Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.MCS, B.Sc.WiMa, B.Sc.ME:
	Vertiefungsbereich. Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich
9	Literature
	D. Bump: Automorphic Forms and Representations, Cambridge University Press
	A. Knapp: Elliptic Curves, Princeton University Press
	S. Lang: Algebraic Number Theory, Addison-Wesley D. Bump et.al.: An Introduction to the Langlands Programm, Birkhäuser
	J.H. Bruinier, G. van der Geer, G. Harder, D. Zagier: The 1-2-3 of Modular Forms, Springer
10	Comment

Mod	Module name										
	Basic Applied Proof Theory										
04-1	Module no. 04-10- 0225/enCredit Points 5 CPWorkload 150 hSelf-study 105 hDuration 105 hFrequency Irregular						•				
Lang Engl	-	Instruct	ion			Person responsible for the Module Prof. Dr. phil. nat. Ulrich Kohlenbach					
1 Courses of the Module											
Course no. Course name Workload (CP)					CP)	Form	of	Contact			

				Teaching	Hours per Week
	04-00-0224-vu	Basic Applied Proof Theory	0	Lecture and Exercise	3
2	namely so-calle	es a brief introduction to some d proof interpretations. The n Kreisel), modified realizability e variants.	nain methods stud	died are: no-counterex	ample
3	(also in higher t 2) understand t treated (modifie 3) can refer to k König's lemma)	nd are able to use formal calc ypes); he soundness and characteriz ed realizability, functional inte pasic applications of these inte	ation theorems for rpretation, mono prpretations (e.g.	or the proof interpreta ptone Functional interp	tions pretation);
4	recommended:	for Participation Introduction to Mathematica ogic as taught in CS programm	-		
5	min, Sta Fachprüfung: U small number o exam. The decis	amination: e Examination (Technical Exan	m of a written tes case, the exam o m is taken and co	st, except when there a can be taken in the for ommunicated during th	are only a m of an oral
6	Requirements of Passing the Fac	on the Award of Credit Points			
7	Grading Final Module Ex • Module Standar	e Examination (Technical Exan	nination, oral / wi	ritten Examination, We	eight: 100%,
8	Usability of the B.Sc Mathemati	Module ik, M.Sc. Mathematik, M.Sc. M	lathematics		

9	Literature Kohlenbach, Ulrich: 'Applied Proof Theory: Proof Interpretations and Their Use in Mathematics'. Springer Monograph in Mathematics, xx+536pp., 2008, Chapters 1-10.
10	Comment recommended: Mathematics: Master (log) Due to content overlap, this course cannot be combined with Applied Proof Theory.

	Com	plex An	alysis							
04-	Module no. 04-10- 0226/en Credit Points 5 CP				elf-study Duration 105 h 1 Semes			Freque Every 2	ncy . semeste	
	guage of glish	Instruct	ion			on responsib . Dr. rer. nat.				
1	Course	s of the	Module							
	Course	no.	Course	name		Workload ((CP)	Form Teacł	-	Contac Hours per Week
	04-00-0225-vu		Complex	x Analysis		0		Lecture and Exercise		3
2	analytic	-Rieman city, Liou	wille's Th	ntial equations, cu neorem and Fundar ted singularities, Re	nental	Theorem of		ral The	eorem ai	
	Cauchy analytic Laurent	-Rieman city, Liou t series a g Outco	wille's Th and isolat	eorem and Fundar	nental	Theorem of		ral The	eorem ai	
2	Cauchy analytic Laurent Learnin Studen - under	-Rieman city, Liou t series a g Outco ts stand ar	ville's Th and isolat mes nd are ab	eorem and Fundar ted singularities, Re le to apply the noti	nental esidue ons, n	I Theorem of Theorem. nethods and	Algebra;	ral The Windir	eorem an ng Numl	per;
	Cauchy analytic Laurent Laurent Studen - under - develo	-Rieman city, Liou t series a g Outco ts stand ar op a basi	iville's Th and isolat mes ad are ab	eorem and Fundar ted singularities, Re	nental sidue ons, n Comp	l Theorem of Theorem. nethods and lex Analysis	Algebra;	ral The Windii eated i	eorem an ng Numl	per;
3	Cauchy analytic Laurent Studen - under - develo - are ab	-Rieman city, Liou t series a g Outco ts stand ar op a basi ole to rec ements f	wille's Th and isolat mes ad are ab ic level o cognise t for Partic	eorem and Fundar ted singularities, Re le to apply the noti f understanding of he treated concept	ons, n Comp s in va	l Theorem of Theorem. nethods and lex Analysis	Algebra;	ral The Windii eated i	eorem an ng Numl	per;
3	Cauchy analytic Laurent Studen - under - develo - are ab Require recomr	-Rieman city, Liou t series a g Outco ts stand ar op a basi ole to rec ements f nended: f Examir	wille's Th and isolat mes ad are ab ic level o cognise t for Partic Analysis nation	eorem and Fundar ted singularities, Re le to apply the noti f understanding of he treated concept cipation and Linear Algebra	ons, n Comp s in va	l Theorem of Theorem. nethods and lex Analysis	Algebra;	ral The Windii eated i	eorem an ng Numl	per;
	Cauchy analytic Laurent Studen - under - develo - are ab Require recomr	-Rieman city, Liou t series a g Outco ts stand ar op a basi ole to rec ements f nended: f Examir	nd isolat mes and are ab ic level o cognise t for Partic Analysis	eorem and Fundar ted singularities, Re le to apply the noti f understanding of he treated concept cipation and Linear Algebra	ons, n Comp s in va	l Theorem of Theorem. nethods and lex Analysis	Algebra;	ral The Windii eated i	eorem an ng Numl	per;

	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, LaG Mathematik
9	Literature Freitag: Funktionentheorie I, Springer Remmert: Funktionentheorie I Conway: Functions of one complex variable, Springer
10	Comment recommended: Mathematics: Bachelor year 2, Teaching Degrees

Module name							
Rese	Research Project Preparation						
Module no.	Credit Points	Workload		Self-study		Duration	Frequency
04-10-0229	5 CP		150 h	1	L05 h	1 Semester	Every 2. semester
Language of	Instruction			Person resp	onsib	le for the Modu	le
German and	English			Prof. Dr. rer.	. nat.	Stefan Ulbrich	

1	Courses of the				
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	04-00-0228-vu	Research Project Preparation	0	Lecture and Exercise	3
2		scientific research (master the of the title, planning the project		che, state of scie	nce,
3	- can make a lit	omes al requirements for a scientific erature review on a clearly def an the work schedule for an ow	fined scientific probler	n	
4	-	for Participation suitable advanced courses plu	us seminar		
5	Studienleistung		ation of the topic of th	ne thesis and its s	
6	Requirements Passing the Stu	on the Award of Credit Points dienleistung			
7	Grading Final Module E • Modul Passed	e Examination (Study Examina	tion, Special Form, We	eight: 100%, Pass	ed / Not
8	Usability of the M.Sc. Mathema	e Module atik, M.Sc. Mathematics			
9	Literature depending on t	opic			
10	Comment recommended:	Mathematics: Master			

Mo	dule nan	ne									
	Rese	arch Pro	oject Pr	eparation					-		
04-2	dule no. 10- 9/en	Credit F	Points 5 CP	Workload 150 h	Self-	f-study Duration 105 h 1 Semester			-	Frequency Every semester	
Language of Instruction English						on responsib . Dr. rer. nat.			ule		
1		s of the l	Module		1						
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week	
	04-00-0	228-vu	Research	n Project Preparation		0		Lecture Exercis		3	
2		ction to		c research (master t e, planning the pro). Literature r	echerche	e, state	of scier	nce,	
3	Studen - know - can m	the usua ake a lite	il require erature r	ements for a scienti eview on a clearly c ork schedule for an o	define	d scientific p					
4			or Parti suitable	cipation advanced courses (olus s	eminar					
5	Final M • Studier	Module	aminatio e Examir : Short o	on: lation (Study Examin ral or written prese awarded at the time	ntatio	on of the topi	c of the t				
6	-		on the A dienleist	ward of Credit Poin	ts						
7	Gradin Final M	-	aminatio	on:							

	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Master

Mod	dule nam	ne								
	Finite	e Mode	l Theory	/						
04-1	dule no. 10- 1/en	Credit F	Points 5 CP	Workload 150 h		study 105 h	Duratio 1 Semes			•
Lan ք Engl	guage of lish	Instruct	ion			on responsik . Dr. rer. nat.			ule	
1	Course	s of the	Module					_		
	Course no. Co		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	230-vu	Finite M	odel Theory		0		Lectur Exercis		3
2	games	ersus cla and the l	Ehrenfeu	odel theory, failure icht-Fraisse metho s of descriptive con	d, defi	nability and I	Locality (I	Hanf, G	aifman);	zero-one
3	Studen theory system enables	treated i s in term s them to	stand an n the co is of thei	d are able to apply urse. They have de r expressiveness ar their knowledge in ion.	velope nd alge	ed an advanc prithmic prop	ed level o verties ov	of unde er finit	erstandin e structu	g of logical Ires, which
4	-		or Parti Introduc	cipation ction to Mathemati	cal Lo	gic.				

	Alternatively: Logic as taught in CS programmes
5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a
	small number of potential participants. In this case, the exam can be taken in the form of an oral
	exam. The decision about the form of the exam is taken and communicated during the first two
	weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Ebbinghaus, Flum: Finite Model Theory
	Grädel et al.: Finite Model Theory and Its Applications
	Libkin: Elements of Finite Model Theory lecture notes (available on http://www.mathematik.tu-darmstadt.de/~otto)
	lecture notes (available on http://www.mathematik.tu-darmstadt.de/ otto)
10	Comment
	recommended: Mathematics: Master (log)
	Due to content overlap, this course cannot be combined with Classical and Non-Classical Model Theory.

Module nam	Module name									
Fluid	Fluid-Structure Interaction									
Module no. 04-10- 0232/en	Credit Points 5 CP	Workload	150 h	Self-study 105 h	Duration 1 Semester	Frequency Every 2. semester				
Language of English	Instruction			Person responsib Prof. Dr. rer. nat.						

1	Courses of the	Module						
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week			
	04-00-0231-vu	Fluid-Structure Interaction	0	Lecture and Exercise	3			
2	equations descu of problem is us motion of the fl	ve will focus on solving the syst ribing the interaction of a fluid sually described by two couple uid and one the motion and, ir mation of the solid.	and a solid. This speci d systems, one describ	al type ping the				
3	-	this lecture, students will be a e context of the fluid-structure						
4	-	Requirements for Participation Partial differential equations						
5								
6	Requirements o	on the Award of Credit Points						
7	Standar	e Examination (Technical Exam d) e Examination (Study Examinat						
8	Usability of the Vertiefungsmoo	Module dul Partielle Differentialgleichu	ngen.					
9	Literature Lecture notes							
10	Comment							

Mo	dule nan				C					
04-2	dule no.	Credit I		dations of Compu Workload 270 h	Self-study Duration				•	
	guage of man	Instruct	tion			on responsib . Dr. rer. nat.			ıle	
1	Course	s of the	Module							
	Course no. Course name			Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-00-0	090-vu	Proposit Logic	ional Logic and Predic	ate	0		Lecture Exercis		3
	04-00-0091-vu Automa Decidab			ta, Formal Languages and ility		0		Lecture and Exercise		3
	Turing comple Theore	machine te proof m, comp	s, decida calculi; pactness	context-free langua ibility and recursive first-order logic: stru theorem, complete der logic; optional:	enur uctur proo	merability; pro es and assign of calculi (Göd	oposition ments, S el's comp	al logic kolemis pletene	c: compa sation, H ess resul	actness, Ierbrand t),
3	Learning Outcomes Students understand and are able to apply the notions, methods and results treated in the course. They have developed a basic level of understanding of formal language theory, basic computability theory and of methods of mathematical logic in application to fundamental issues in theoretical computer science. They are able to recognise the relevant concepts and ideas in related fields of mathematics and theoretical computer science.									
4	•									d ideas in
	recom		for Partions solid ma	cipation athematical foundat	ions	in Analysis an	d Linear	Algebra	a	d ideas in
5	Form o	nended: f Exami r	solid ma	thematical foundat	ions	in Analysis an	d Linear	Algebra	a	d ideas in
5	Form o	nended: f Examir odule Ex	solid ma nation kaminatio	thematical foundat						

	1
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	Passed)
8	Usability of the Module B.Sc. Mathematik
9	Literature Hopcroft, Motwani, Ullman: Einführung in die Automatentheorie, formale Sprachen und Komplexitätstheorie Schöning: Theoretische Informatik – kurz gefasst Boolos, Burgess, Jeffrey: Computability and Logic Burris: Logic for Mathematics and Computer Science Skripte (elektronisch unter <u>www.mathematik.tu-darmstadt.de/~otto</u>)
10	Comment

Module nam	Module name								
Inter	Interpolation Theory								
Module no.	Credit Points	Workload		Self-study	Duration	Frequency			
04-10-0234	5 CP		150 h	105 h	1 Semester	Irregular			
Language of	Instruction			Person responsib	Person responsible for the Module				
German and	English			Prof. Dr. rer. nat.	Reinhard Farwi	5			

1	Courses of the	Module						
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week			
	04-00-0233-vu	Interpolation Theory	0	Lecture and Exercise	3			
2	Study Content Lebesgue space applications	es, Sobolev spaces and their inter	polation spaces, real	and complex in	terpolation,			
3	 develop an ad are able to ex 	mes nd are able to apply the notions, i vanced level of understanding of tend their knowledge in this field rm supervised research in this fie	the theory of functio		ourse			
4	-	Requirements for Participation recommended: Functional Analysis						
5	min, St Fachprüfung: U small number c exam. The deci		of a written test, exce use, the exam can be t is taken and commun	pt when there taken in the for icated during tl	are only a m of an oral he first two			
6	Requirements Passing the Fac	on the Award of Credit Points hprüfung						
7	Grading Final Module Ex Modul Standa	e Examination (Technical Examin	ation, oral / written E	xamination, We	eight: 100%,			
8	Usability of the B.Sc Mathemat	: Module ik, M.Sc. Mathematik, M.Sc. Mat	hematics					
9		öm, J., Interpolation Spaces. An I terpolation Theory, Function Spa		-	Science			

	Lunardi, A., Interpolation Theory. Publ. Scuola Normale Superiore, Vol. 9, 2009
10	Comment recommended: Mathematics: Master (ana)

Мос	dule nam	ne								
	Com	olex An	alysis 2							
04-1	dule no. LO- 5/de	Credit P	Points 5 CP	Workload 150 h	Self	study 105 h	Duratio 1 Semes		Freque Every 2	e ncy 2. semester
Lang Gerr	guage of man	Instruct	ion			on responsib . Dr. rer. nat.				
1 Courses of the Module										
	Course no.		Course	name		Workload ((CP)	Form Teach		Contact Hours per Week
	04-00-03	234-vu	Complex	Analysis 2		0		Lecture Exercis		3
2	Partial	nal map	decompo	s transforms and Ri osition and product iptic curves				on		
3	After su		ly passin	g this module, stud metric and algebrai			thods of			
4	•	ements f ex Analys	or Partic is	ipation						
5		f Examin odule Ex	a tion aminatio	on:						
	•			ation (Study Examination (Technical Examination)		•				
6	Require			ward of Credit Poin				,		

7	Grading Final Module Examination:
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module
9	Literature Freitag, Busam: Funktionentheorie 1 Conway: Functions of one complex variable I+II
10	Comment

Мо	dule nam	ne								
	Incor	npleter	ness of F	ormal Systems						
04-	Module no.Credit Points04-10-5 CP0238/en		Points 5 CP	Workload 150		study 105 h	Duration 1 Semester		Frequency Irregular	
Lan	guage of	Instruct	tion		Pers	on responsib	le for the	e Modu	ıle	
Eng	glish				Prof	. Dr. rer. nat.	Thomas S	Streich	er	
1	Course	s of the	Module							
-	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	236-vu	Incomple	eteness of Formal Sy	/stems	stems 0 Lecture Exercise				3
2	Study Content Gödel's Incompleteness Theorems, Löb's Theorem, Provability Logic									
3	Studen	Learning Outcomes Students understand the difference between validity and provability, in particular Goedel's first and secod Incompletness Theorems as well as Loeb's Theorem. They develop a feeling for what								

formal systems can achieve and what not.						
Requirements for Participation recommended: Introduction to Mathematical Logic						
Form of Examination Final Module Examination:						
 Module Examination. Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) 						
Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.						
Requirements on the Award of Credit Points Passing the Fachprüfung						
 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 						
Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics						
Literature lecture notes provided online						
Comment recommended: Mathematics: Master (log)						

Mod	Module name										
Introduction to Game Theory											
	lule no.	Credit Points Workload			Self-	study	Duration 1 Semester		Frequency Every 2. semester		
04-1 0241	-	5 CP		150 h		105 h					
Lang	guage of	Instruct	ion			Perse	on responsib	le for the	Modu	le	
Engl	ish					Prof.	Dr. rer. nat.	Stefan Ul	brich		
1	Courses of the Module										
	Course no. Course name						Workload (CP)	Form	of	Contact

				Teaching	Hours per Week						
	04-00-0239-vu	Introduction to Game Theory	0	Lecture and Exercise	3						
2	and strategic ga of solution of a	ve and cooperative game theory ames. Fixed point theorems (e.g game (e.g. Nash equilibrium). T inimax theorem). Impossibility ms).	. Brouwer). Various heorems of exister	s concepts nce of							
3	Students become purposes, and of notions in term game theory, a	Learning Outcomes Students become aware of different areas in game theory, of its practical purposes, and of its current limits. They will be able to discuss technical notions in terms of examples, derive classical results in non-cooperative game theory, and exemplify the limitations of these results. They will also be able to evaluate game-theoretic results as modelling tools.									
4	Requirements for Participation Allgemeines mathematisches Grundwissen aus den 1,2,3 Fachsemestern										
5			•								
6	Requirements	on the Award of Credit Points									
7	 Grading Final Module Examination: Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) 										
8	Usability of the Ba.Sc.Math: Wa	e Module ahlpflichtbereich, Ergänzungsbe	reich								
9	Literature Osborne, Marti	n J. (2004), An introduction to g	ame theory								
10	Comment										

	Curv	e Estima	ation								
04-	dule no. 10- 3/de	Credit F	Points 9 CP	Workload 270 h	Self-study 180 h	Duration 1 Semester					
	guage of man	Instruct	ion		Person responsible for the Module Prof. Dr. rer. nat. Michael Kohler						
1	Course	s of the	Module								
	Course	Courses of the Module Course no. Course name			Workload (-	orm of eaching	Contact Hours per Week			
	04-00-0241-vu Curve Es			timation	0	-	ecture and ercise	6			
estimates, application of empirical process theory), regression estimation with random (local averaging, least squares estimates, universal consistency, optimal rate of conver data-dependent choice of parameters)						-					
3	Studen - under - develo - are ab	stand ar op an ad lle to ext	nd are ab vanced le cend thei	le to apply the notic evel of understandi r knowledge in this rvised research in th	ng of the theory an field						
4	-		for Partic	Sipation lity Theory, Mathen							
				inty meory, wathen							
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 90 min. Standard) 										
	•		e Examir		amination, oral / w	vritten Exam	nination, Du	ration 90			

	T
	exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Devroye: A Course In Density Estimation.
	Devroye, Lugosi: Combinatorial methods in density estimation.
	Györfi, Kohler, Krzyzak, Walk: A distribution-free theory of nonparametric regression.
	van de Geer: Empirical Processes in M-Estimation.
10	Comment
	recommended: Mathematics: Master (sto)

	Math	nematio	al Foun	dations of Functio	onal Programmin	g 1		
04-1	Module no. 04-10-Credit PointsWorkload0247/de5 CP150		Workload 150 h	Self-study 105 h	Duration 1 Semester			
Lan	guage of	Instruc	tion		Person responsib	le for the Mo	odule	
Ger	man				Prof. Dr. rer. nat.	Thomas Stre	icher	
1	Courses of the Module							
	Course no. Course name			name	Workload ((-	rm of aching	Contact Hours per Week
	04-00-0259-vu Mathematical Foundations Functional Programming 1						ture and rcise	3
2		onal ser	nantics, o nal progr	denotational seman	tics, domain theor	y, logical rela	tions,	

3	Learning Outcomes								
	obtaining basic knowledge of operational and denotational semantics								
	of the kernel language LCF								
4	Requirements for Participation								
	Einf. in die Logik								
5	Form of Examination								
	Final Module Examination:								
	Module Examination (Technical Examination, Technical Examination, Standard)								
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)								
6	Requirements on the Award of Credit Points								
7	Grading Final Module Examination:								
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) 								
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed) 								
8	Usability of the Module								
9	Literature								
	T. Streicher: Domain-Theoretic Foundations of Functional Programming, World Scientific (2006)								
10	Comment								

Mod	Module name										
	Mathematical Foundations of Functional Programming 1										
Mod 04-10 0247	-	Credit Points 5 CP	Workload	150 h	Self-study 105 h	Duration 1 Semester	Frequency Irregular				
Lang Engli	•	Instruction			Person responsible for the Module Prof. Dr. rer. nat. Thomas Streicher						
1	Courses of the Module										

											
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-00-0245-vu	Mathematical Foundations of Functional Programming 1	0	Lecture and Exercise	3						
2	Study Content operational semantics, denotational semantics, domain theory, logical relations, logic of functional programs										
3	Students know the main metho	Learning Outcomes Students know the basic techniques of operational and denotational semantics. They can use the main methods for proving functional programs correct. They master logical relations e.g. for proving computational adequacy. They know how to solve recursive domain equations.									
4	-	for Participation Introduction to Mathematical L	ogic								
5	Final Module Ex Modul min, Sta Fachprüfung: U small number o exam. The decis	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 									
6	Requirements of Passing the Fac	on the Award of Credit Points hprüfung									
7	Grading Final Module Ex • Modul Standar	e Examination (Technical Exami	nation, oral / written	Examination, Wo	eight: 100%,						
8	Usability of the B.Sc Mathemat	: Module ik, M.Sc. Mathematik, M.Sc. Ma	thematics								
9	Literature T. Streicher: Do	main-Theoretic Foundations of	Functional Programm	ning, World Scier	tific (2006)						
10	Comment recommended:	Mathematics: Master (log)									

Mo	dule nan	ne										
	Math	nematic	al Foun	dations of Functio	onal P	Programmin	g 2					
04-2	dule no. 10- 8/de	Credit F	Points 5 CP	Workload 150 h	Self-	study 105 h	Duration 1 Semes		Freque Every 2	ency 2. semester		
	guage of	Instruct	ion		Pers	on responsib	le for the	• Modi	ıle			
	man	motract			Person responsible for the Module Prof. Dr. rer. nat. Thomas Streicher							
1	Course	s of the	Module		Į							
	Course no. Course name		name		Workload (CP)		Form of Teaching		Contact Hours per Week			
	04-00-0	04-00-0260-vu Mathematical Foundations Functional Programming 2				0		Lecture and Exercise		3		
2	Study C full abs		comput	ability in domains								
3	system den Require	otationa ements f	erstandir I models For Partic	ng of the relation be c. extension of the n cipation agen der funktionale	otion	of computat	oility to de	omains	5.			
5		Module	aminatio e Examir	on: nation (Study Examin nation (Technical Exa						-		
6	Require	ements o	on the A	ward of Credit Poin	ts							
7	Gradin Final M	odule Ex		on: nation (Study Examin	natior	n, Study Exam	nination,	Weigh	t: 0%, P	assed / Not		
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) 											

8	Usability of the Module
9	Literature T. Streicher: Domain-Theoretic Foundations of Functional Programming, World Scientific (2006)
10	Comment

Mod	lule nam	ne								
	Math	ematic	al Foun	dations of Functio	nal I	Programmin	g 2			
Mod 04-1 0248		Credit F	Points 5 CP	Workload 150 h	Self	Self-study Duratio				-
_	Language of Instruction English					on responsib				
1	-									
	Course no. Cours		Course	name		Workload ((CP)	Form Teacł	•••	Contact Hours per Week
	04-00-02	246-vu		atical Foundations of al Programming 2		0		Lecture and 3 Exercise		3
2	Study C full abs ⁻		comput	ability in domains						
3	Student of full a logical i	bstractions relations	ove basi on and u . Moreo	c facts about recurs nderstand how to c ver, they know basic to denote all compu	onstr c fact	uct a fully ab s about comp	stract mo	del for	r PCF usii	ng Kripke
4	-		or Partic Mathem	cipation natical Foundations	of Fu	nctional Prog	ramming	g 1		
5			aminatio	on: ation (Technical Exa	amina	ation, oral / w	vritten Ex	aminat	tion, Sta	ndard)
	-	-	-	e exam is taken in fo ial participants. In th			-			-

	exam. The decision about the form of the exam is taken and communicated during the first two
	weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	T. Streicher: Domain-Theoretic Foundations of Functional Programming, World Scientific (2006)
10	Comment
	recommended: Mathematics: Master (log)

Mo	dule nan	ne									
	Sumi	marizin	g a Mat	hematical Lecture	(sing	gle)					
Module no.Credit PointsWorkload04-10-1 CP30 h		Self-study 30 h		Duration 1 Semester		Frequency Every 2. semester					
	guage of man	Instruct	tion			-		o le for the des Fachl			
1	Course	s of the	Module								
	Course no. Course			name		Workload (CP)		CP)	Form of Teaching		Contact Hours per Week
	04-00-0261-pj Summar Lecture			izing a Mathematical (single)				Accompanying Self-study		0	
2	-	Study Content Depending on topic									
3	Learning Outcomes Die Studierenden können aus einem anspruchsvollen mathematischen Fachvortrag die wesentlichen Verständnisschwierigkeiten identifizieren, aufklären										

	und einen Fachvortrag in eigenen Worten formulieren und schriftlich gut
	verständlich kommunizieren
4	Requirements for Participation
	Arbeitstechniken in der Mathematik
5	Form of Examination
5	
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Weight: 100%, Passed /
	Not Passed)
8	Usability of the Module
	Bachelor Mathematik
9	Literature
10	Comment
	Verantwortlich: Studiendekan

Mo	Module name										
	Summarizing a Mathematical Lecture (single)										
04-10-								Frequency Every 2. semester			
Language of InstructionPerson responsible for the ModEnglishStudiendekan*in des Fachbereid1Courses of the Module											
	Course no. Course		name		Workload ((CP)	Form o Teachi	•••	Contact Hours per Week		
	04-00-0242-pj Summarizing a Mathematical Lecture (single)				0		Accomp Self-stu	, 0	1		

2	Study Content
	depending on topic
3	Learning Outcomes Die Studierenden können aus einem anspruchsvollen mathematischen Fachvortrag die wesentlichen Verständnisschwierigkeiten identifizieren, aufklären und einen Fachvortrag in eigenen Worten formulieren und schriftlich gut verständlich kommunizieren
4	Requirements for Participation Arbeitstechniken in der Mathematik
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Study Examination, Study Examination, Weight: 100%, Passed / Not Passed)
8	Usability of the Module Bachelor Mathematik
9	Literature
10	Comment Verantwortlich: Studiendekan

Module name											
Sum	Summarizing a Mathematical Lecture (double)										
Module no. 04-10- 0253/de	Credit Points 2 CP	Workload 60 h	Self-study 60 h	Duration 1 Semester	Frequency Every 2. semester						
Language of German	Instruction		Person responsible for the Module Studiendekan*in des Fachbereichs 04								

1	Courses of the Module											
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week							
	04-00-0262-pj	Summarizing a Mathematical Lecture (double)	0	Accompanying Self-study	0							
2	Study Content Depending on topic											
3	Learning Outcomes Die Studierenden können aus einem anspruchsvollen mathematischen Fachvortrag die wesentlichen Verständnisschwierigkeiten identifizieren, aufklären und einen Fachvortrag in eigenen Worten formulieren und schriftlich gut verständlich kommunizieren											
4	Requirements for Participation Arbeitstechniken in der Mathematik											
5	Form of Exami Final Module E • Modu		tion, Study Examinatic	on, Passed / Not P	assed)							
6	Requirements	on the Award of Credit Points										
7	Grading Final Module E • Modu Not Pa	le Examination (Study Examina	tion, Study Examinatio	on, Weight: 100%,	Passed /							
8	Usability of the Module Bachelor Mathematik											
9	Literature											
10	Comment Verantwortlich	n: Studiendekan										

Module name

	Sumi	marizin	g a Mat	hematical Lecture	e (dou	ıble)				
Module no. 04-10- 0253/en		Credit F	Points 2 CP			study 30 h	Duration 1 Semester		Frequency Every 2. semest	
Language of Instruction English						on responsib iendekan*in				
1 Courses of the Course no.			Module Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	243-рј	Summar Lecture	izing a Mathematical (double)		0		Accom Self-stu	panying udy	2
2	Study C depend	Content ling on to	opic							
3	Learning Outcomes Die Studierenden können aus einem anspruchsvollen mathematischen Fachvortrag die wesentlichen Verständnisschwierigkeiten identifizieren, aufklären und einen Fachvortrag in eigenen Worten formulieren und schriftlich gut verständlich kommunizieren									
4	-		f or Partic en in der	cipation Mathematik						
5			aminatio	on: nation (Study Exami	natior	n, Study Exam	nination,	Passed	d / Not P	assed)
6	Require	ements o	on the A	ward of Credit Poir	its					
7	 Grading Final Module Examination: Module Examination (Study Examination, Study Examination, Weight: 100%, Passed / Not Passed) 									
8		ty of the or Mathe	e Module ematik							
9	Literatı	ure								
10	Comment									

Мо	dule no.			nd Noncommutat Workload	Self-study	Duratio	n	Freque	encv
04-	10-0258		9 CP	270 h		1 Semes		Irregul	-
Language of Instruction					Person responsi	ble for the	e Modu	ule	
German and English					Prof. Dr. rer. nat.	Burkhard	d Kümn	nerer	
1	Course	s of the l	Module						
	Course no.		Course name		Workload (CP)	Form of Teaching		Contact Hours per Week
	04-00-0	252-vu	-	ralgebras and mutative Probability	0		Lecture Exercis		6
class operators and the algebra of all bounded operators on a Hillbert space, operator topologies, von Neumann algebras, normal states and representations, basic notions of quantum probability (Gleason's Theorem, probability spaces, compound systems, random variables, conditional expectations, transition operators), stationary Markov processes and examples from physics.					or				
	topolog quantu variable	gies, von m proba es, condi	Neumar bility (Gl tional ex	nn algebras, normal eason's Theorem, p	states and repres probability spaces,	entations compour	, basic nd syste	notions ems, rai	of ndom
3	topolog quantu variable exampl Learnin Student mechar Neuma are able expecta	gies, von m proba es, condi es from g Outco ts are ab nics, to d nn algeb e to tran ation, tra	Neumar bility (Gl tional ex physics. mes le to use efine an ras, to co sfer the	nn algebras, normal eason's Theorem, p	states and repres probability spaces, on operators), sta r distinguishing cla products, to disting tes with correspo bability theory, su	entations compour tionary M assical phy guish vario nding rep uch as ran	, basic nd syste arkov p ysics fro ous top resent dom va	om qua oologies ations, f	of ndom es and ntum on von inally they conditiona
	topolog quantu variable exampl Learnin Student mechar Neuma are able expecta illustrat	gies, von m proba es, condi es from g Outco ts are ab nics, to d nn algeb e to tran ation, tra te them i ements f nended:	Neumar bility (Gl tional ex physics. mes le to use efine an ras, to co sfer the nsition co in physic	an algebras, normal eason's Theorem, p pectations, transiti e Bell's inequality fo d interpret tensor p onstruct normal sta basic notions of pro operator, Markov p ally relevant examp	states and repres probability spaces, on operators), sta r distinguishing cla products, to disting tes with correspo obability theory, su rocess, to the ope oles.	entations compour tionary M assical phy guish vario nding rep uch as ran rator alge	, basic nd syste arkov p ysics fre ous top resenta dom va braic c	om qua oologies ations, f ontext a	of ndom es and ntum on von inally they conditiona and to
4	topolog quantu variable exampl Learnin Student mechar Neuma are able expecta illustrat Require recomm is helpf	gies, von m proba es, condi es from g Outco ts are ab nics, to d nn algeb e to tran ation, tra te them i ements f nended:	Neumar bility (Gl tional ex physics. mes le to use efine an ras, to co sfer the nsition co for Partic Function	e Bell's inequality fo d interpret tensor p onstruct normal sta basic notions of pro operator, Markov p ally relevant examp cipation nal analysis, basic ki	states and repres probability spaces, on operators), sta r distinguishing cla products, to disting tes with correspo obability theory, su rocess, to the ope oles.	entations compour tionary M assical phy guish vario nding rep uch as ran rator alge	, basic nd syste arkov p ysics fre ous top resenta dom va braic c	om qua oologies ations, f ontext a	of ndom es and ntum on von inally they conditiona and to

	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	R. V. Kadison, J.R. Ringrose: Fundamentals of the Theory of Operator Algebras I,II.
	M. Takesaki: Theory of Operator Algebras I.
	Skripte aus B. Kümmerer, H. Maassen: Probability in Open Quantum Systems, in Vorbereitung.
10	Comment
	recommended: Mathematics: Master (alg, ana)

	dule nam Optii		n in fun	ction spaces						
Module no. Credit Points Workload				-	Self-	Self-study Duratio			n Frequen	
04-10-0259 5 CP			150 h		105 h	1 Semes	ter	Irregula	r	
Language of Instruction					Pers	on responsib	le for the	Modu	ıle	
Ger	man and	English			Prof	Dr. rer. nat.	Stefan Ul	brich		
1	Course	s of the	Module							
	Course no. Course name		name		Workload ((CP)	Form Teacł		Contact Hours per Week	
04-00-0253-vu Optimization in function spaces 0 Lecture and 3 Exercise										
2	Study C	Content								
	separat	ion theo	prems; du	h spaces: Gâteaux- uality theory, minim prems: Karush-Kuhr	ax th	eorem, Lagra	nge duali	ty, Fer	nchel dua	lity;

	and Zowe/Kurcyusz
3	Learning Outcomes Students - know prototypical examples for infinite dimensional optimization methods - can apply essential techniques of convex anlysis - know techniques for the analysis of optimization methods in infinite dimensional spaces - know and understand basic algorithms for the sollution of infinite dimensional optimization problems
4	Requirements for Participation recommended: Nonlinear Optimization, recommended: Functional Analysis
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Luenberger: Optimization by Vector Space Methods; Ekeland, Temam: Convex Analysis and Varational Problems
10	Comment recommended: Mathematics: Master (opt)

Mo	dule nan	ne								
	Reali	zability			-					
04-2	dule no. 10- 1/de	Credit F	Points 5 CP	Workload 150 h	Self-s	-	Duratio 1 Semes		Freque Every 2	e ncy 2. semester
	guage of	Instruct	ion		Perso	on responsib	le for the	e Modu	ule	
	man					Dr. rer. nat.				
1	Course	s of the	Module					-		
			Form Teach	-	Contact Hours per Week					
	04-00-0	255-vu	Realizab	ility		0		Lectur Exercis		3
2	Study C realizat		odified Ro	ealizability, assemb	lies, tri	ipos, effectiv	e topos			
	provab Goedel	ility in fo 's incom	ormal sys pletenes	ood understanding tems. Moreover, th s theorems and the	ey shc	ould adopt th				
4	-	e ments f die Logil	f or Parti o k	ipation						
5		00000	aminatio	on: ation (Technical Ex	amina	tion. Technic	al Exami	nation	. Standa	ard)
6	Require			ward of Credit Poin						
7	Gradin; Final M	odule Ex		on: ation (Technical Ex	amina	tion, Technic	cal Exami	nation,	, Weight	t: 100%,
8	Usabili	ty of the	Module							
-		,								

9	Literature Skript online erhältlich
10	Comment

Мо	dule nam	ne								
	Raliz	ability								
04-	dule no. 10- 51/en	Credit F	Points 5 CP	Workload 150 h		study 105 h	Duration 1 Semes		Freque Irregula	-
Language of Instruction English						on responsib . Dr. rer. nat.				
1	Course	s of the	Module							
	Course no. Course		name		Workload ((CP)	Form Teacł	-	Contact Hours per Week	
	04-00-0	263-vu	Realizab	ility		0		Lectur Exercis		3
2	Study C realizat		odified Ro	ealizability, assemb	lies, t	ripos, effectiv	ve topos			
3	Studen Moreov	ver, they	stand Kle know th	eene's number real ne notion of partial dea how to interpre	comb	inatory algeb	ra and its	s most	importa	nt
4	-		or Partic Introduc	c ipation ction to Mathematic	cal Lo	gic				
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) 									
	small n exam. 1	umber o The decis	f potent sion abou	e exam is taken in f ial participants. In t ut the form of the e sed on the prospec	his ca xam i	se, the exam s taken and c	can be ta ommunio	aken in cated o	the fori luring th	m of an ora

6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature lecture notes provided online
10	Comment recommended: Mathematics: Master (log)

Mod	dule nam	ne									
	Fouri	ier Ana	lysis								
Module no. 04-10- 0263/de			Workload	150 h	Self-studyDurationFrequency105 h1 SemesterIrregular					•	
Lang	guage of	Instruct	tion			Pers	on responsib	le for the	e Modu	ule	
Geri	man					Prof.	Dr. rer. nat.	Matthias	Hiebe	r	
1	Course	s of the	Module								
	Course no. Course		name		Workload (CP		CP)	Form Teacl	•••	Contact Hours per Week	
	04-00-0	256-vu	Fourier A	Analysis			0		Lectur Exercis		3
2	Study C Calderc		und sing	ular integral	operate	ors, in	terpolation,	Fourier tr	ransfoi	rmation,	multipliers
3	Student - under - develo	stand ar op a bas	nd are ab ic level o	funderstand	ling of s	singul	nethods and ar integrals a rious fields o	nd singul	ar inte		

4	Requirements for Participation recommended: Analysis, Gewöhnliche Differentialgleichungen, Complex Analysis.
5	Form of Examination Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999. W. Rudin, Real and Complex Analysis, McGraw Hill, 3. Auflage 1987. E. Stein, Harmonic Analysis, Princeton University Press. L. Grafakos, Classical and Modern Fourier Analysis, Springer.
10	Comment recommended: Mathematics: Bachelor year 3 (ana)

Мо	dule nam	ne								
	Four	ier Anal	ysis							
04-	dule no. 10- 53/en	Credit F	Points 5 CP	Workload 150 h	Self-study 105 h	study Duration 105 h 1 Semester			Frequency Irregular	
Language of Instruction English					Person responsik Prof. Dr. rer. nat.			е		
1	Course	s of the l	Module		ł					
			orm o eachi		Contact Hours per Week					
	04-00-0	256-vu	Fourier A	Analysis	0	-	ecture a vercise		3	
2	Study C Caldero		und sing	ular integral operato	ors, interpolation,	Fourier tran	nsform	nation,	multipliers	
3	Studen - under - develo - are ab	stand an op a basi ile to rec	id are ab c level o	le to apply the notion f understanding of s he treated concepts	singular integrals a	ind singular	integ			
4	-			, Gewöhnliche Diffe	erentialgleichunge	n, Complex /	Analy	sis.		
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking									
6	the exam. Requirements on the Award of Credit Points									
	Passing	the Fac	hprüfung	g (technical examina	ation);					

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999. W. Rudin, Real and Complex Analysis, McGraw Hill, 3. Auflage 1987. E. Stein, Harmonic Analysis, Princeton University Press. L. Grafakos, Classical and Modern Fourier Analysis, Springer.
10	Comment recommended: Mathematics: Bachelor year 3 (ana)

Мос	dule nan	ne									
	Incor	npleter	ness of F	ormal Syst	ems						
Moc 04-1 0265		Credit Points 5 CP		Workload	150 h	Self-study 105 h		Duration 1 Semester		Frequency Every 2. semester	
Language of Instruction German						on responsib Dr. rer. nat.					
1	Course	s of the	Module								
	Course	no.	Course	name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	258-vu	Incompl	eteness of Formal Systems		0		Lecture and Exercise		3	
2	Study C Gödel's		leteness	Theorems,	Löb's Tł	neore	m, Provability	y Logic			·
3	The stu - know - are ab	the diffe	erence be ove Göde	etween valid el's 1st and 2 theorem	•	•	ability teness theore	ems			

	- can assess the scope of formal systems and their limitations.
4	Requirements for Participation
	Einführung in die Mathematische Logik
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, Technical Examination, Standard)
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
9	Literature
	Skript online erhältlich
10	Comment

Мо	dule nam	ne										
	Optir	nizatio	n with p	artial diffe	rential	equations						
Module no.		Credit Points		Workload		Self-study		Duration	Frequency			
04-:	14-10-0279 5 CP			150 h	105	105 h 1 Semes		ster Irregular				
Lan	guage of	Instruc	tion			Person respon	sible	e for the Mod	ule			
Ger	man and	English				Prof. Dr. rer. nat. Stefan Ulbrich						
1	Courses	s of the	Module									
	Course no. Course name				Workloa			n of hing	Contact Hours per			

					Week
	04-00-0276-vu	Optimization with partial differential equations	0	Lecture and Exercise	3
2	constraints: exi semilinear prob necessary and s	of partial differential equation stence and uniqueness, first- plems with control constraint second-order sufficient condi ewton methods, SQP method	order necessary c s: existence, Nem tions; algorithms:	onditions, adjoint equ yzkii operators, first-c	uations; order
3	problems. - are proficient solutions, optin	omes optimization problems with in the techniques for the the nality conditions) and can ap gorithms for the solution of s	oretical analysis c ply these.		
4	recommended:	for Participation Nonlinear Optimization and ds (engineering course), PDE	•	•	ns (e.g. PDE
5	min, Sta Fachprüfung: U small number o exam. The decis		orm of a written te is case, the exam cam is taken and c	est, except when ther can be taken in the fo communicated during	e are only a orm of an oral the first two
6	Requirements Passing the Fac	on the Award of Credit Point hprüfung	S		
7	Grading Final Module Ex Modul Standar	e Examination (Technical Exa	mination, oral / v	vritten Examination, V	Veight: 100%,
8	Usability of the B.Sc Mathemat	e Module ik, M.Sc. Mathematik, M.Sc.	Mathematics		
9		nale Steuerung partieller Diff M. Ulbrich, S. Ulbrich: Optimi			

10	Comment recommended: Mathematics: Master (opt)

		ch and								_	
	dule no.	Credit F		Workload	270 1		study	Duratio		Freque	-
	10-0280		9 CP		270 h	n 180 h 1 Semester Irregular					
	guage of		ion				on responsib				
	rman and	•				Apl. F	Prof. Dr. rer.	nat. Stef	ten Roo	h	
1	Course	s of the l	Module			<u> </u>					
	Course	no.	Course	name	ame		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	202-vu	Banach a	and C*-algebr	as		0		Lecture Exercis		6
	-					-	ebras, positiv e states, Toe		•	esenta	tions, GNS
3	constru Learnin Studen - under - explai	iction, iri ng Outco ts learn t istand an n the pro	reducible mes to d explain	e representa n the basic p asic results i	tions ar rinciple n Gelfa	nd pur	anach- and C	eplitz ope	erators	esenta	tions, GNS
3	constru Learnin Studen - under - explai - apply	iction, iri ing Outco ts learn t istand an n the pro the theo	reducible mes to d explain pofs of b rry to bas	e representa n the basic p asic results i sic problems	tions ar rinciple n Gelfa	nd pur	anach- and C	eplitz ope	erators	esenta	tions, GNS
	constru Learnin Studen - under - explai - apply Require	iction, iri ng Outco ts learn t stand an n the pro the theo ements f	reducible mes d explain pofs of b rry to bas	e representa n the basic p asic results i sic problems	tions ar rinciple n Gelfa	nd pur	anach- and C	eplitz ope	erators	esenta	tions, GNS
4	constru Learnin Studen - under - explai - apply Require recomr	iction, iri ng Outco ts learn t stand an n the pro the theo ements f	reducible mes d explain oofs of b ory to bas for Partic Functior	e representa n the basic p asic results i sic problems cipation	tions ar rinciple n Gelfa	nd pur	anach- and C	eplitz ope	erators	esenta	tions, GNS
	constru Learnin Studen - under - explai - apply Require recomr	iction, iri ing Outco ts learn t stand an n the pro the theo ements f nended:	reducible mes d explain oofs of b ory to bas for Partic Function	e representa n the basic p asic results i sic problems cipation nal Analysis	tions ar rinciple n Gelfa	nd pur	anach- and C	eplitz ope	erators	esenta	tions, GNS
4	constru Learnin Studen - under - explai - apply Require recomr	iction, iri ing Outco ts learn t stand an n the pro the theo ements f mended: f Examin	reducible mes d explain oofs of b ory to bas for Partic Function tation caminatic e Examin	e representa n the basic p asic results i sic problems cipation nal Analysis	rinciple n Gelfa in ope	nd pur	anach- and C	eplitz ope	rators		

6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Arveson: An Invitation to C*-Algebras;
	Davidson: C*-Algebras by Example;
	Murphy: C*-Algebras and Operator Theory.
10	Comment
	recommended: Mathematics: Master (ana)

Mod	lule nan	ne								
	Gam	e Theor	·у							
04-1	Module no. 04-10- 0281/de		Points 6 CP	Workload 180 h		study 135 h	Duration 1 Semester		Frequency Every 2. semest	
-	Language of Instruction German					on responsib Dr. rer. nat.			ule	
1	Course	s of the	Module							
	Course no. Course		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0	277-vu	Game Tł	neory		0		Lecture and Exercise		3
2	Study C	Content								
	Non-cooperative games: Two-person-zerosum n-person-games, three-person-zerosum-game Cooperative games: Solution concepts: Stable games, applications						·	C	mes,	
3	Learnin	g Outco	mes							
	Nach d	em Besu	ch des N	1pduls verstehen di	e Stuc	lierenden die	e Grundko	onzept	е	

	der kooperativen und nicht-kooperativen Spieltheorie
4	Requirements for Participation
	Grundkenntnisse in Analysis und linearer Algebra
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
	Module Examination (Technical Examination, Technical Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module
9	Literature W. Krabs: Spieltheorie: Dynamische Behandlung von Spielen. Verlag B.G. Teubner 2005
10	Comment

Mo	dule nam	ne									
Riemannian Geometry											
Module no. Credit Points		Workload		Self-	study	Duration	า	Frequen	су		
04-1	04-10-0288 9 CP			270 h		180 h 1 Semester		ter	Irregular		
Lan	guage of	Instruct	ion			Person responsible for the Module					
Ger	man and	English				Prof. Dr. rer. nat. Karsten Große-Brauckmann					
1	Course	s of the I	Module								
	Course no. Course		name		Workload (CP)		Form of Teaching		Contact Hours		

	I		I		1						
					per Week						
	04-00-0283-vu	Riemannian Geometry	0	Lecture and Exercise	6						
2	geodesics, expo	or fields; Riemannian metri mential map, Hopf-Rinow tl i fields, Hadamard theorem	neorem, hyperbo	•	-						
3	Learning Outcomes Students -have an understanding of the abstraction from submanifolds to manifolds -can describe how parallel transport leads to the notion of an invariant derivative -are able to deal with the technicalities of the curvature tensor -can formulate topological and geometric statements with curvature assumptions										
4	-	for Participation Differential Geometry									
5	min, Sta Fachprüfung: U small number o exam. The decis		form of a written his case, the exan exam is taken and	test, except when there m can be taken in the for I communicated during t	are only a rm of an oral he first two						
6	Requirements of Passing the Fac	on the Award of Credit Poir hprüfung	nts								
7	Grading Final Module Ex Module Standar	e Examination (Technical Ex	amination, oral /	written Examination, W	eight: 100%,						
8	Usability of the B.Sc Mathemat	: Module ik, M.Sc. Mathematik, M.Sc	. Mathematics								
9	Gallot, Hulin, La	n manifolds, an introductio afontaine: Riemannian Geor annian Geometry									

Мо	dule nam	ne									
	Bana	ch alge	bras and	d numerical analy	sis						
Мо	dule no.	Credit F	oints	Workload	Self	-study	Duratio	n	Freque	ency	
04-	10-0290		9 CP	270 h	180 h 1 Semester Irregular						
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ule		
Ger	man and	English			Apl.	Prof. Dr. rer.	nat. Stef	fen Roo	ch		
1	Course	s of the l	Module								
	Course	no.	Course	name		Workload ((CP)	Form Teacł	-	Contact Hours per Week	
	04-00-0	285-vu	Banach / Analysis	Algebras and Numeric	al	0		Lectur Exercis		6	
3	approxi for spec Learnin Studen - under concep - transla - apply	imation, cial class g Outco ts learn t stand an ts in nun ate certa techniqu	fractal a es of ope mes to d explain nerical a in quest ues from	n the basic aspects	of the nalysi	nces, the alge e interplay be is to algebraio gebras to solv	tween di problem e these p	e finite screte ns problen	section: and con	s method	
4	-		or Partic Functior	Sipation nal analysis; basic ki	nowle	edge in Banac	h algebra	as usefi	ul		
5	Final M	Module min, Sta	aminatio e Examin andard)	on: lation (Technical Ex e exam is taken in f							
		-	•	ial participants. In t			•				

	exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Böttcher/Silbermann: Introduction to large truncated Toeplitz operators, Hagen/R./Silbermann: C*-Algebras and Numerical Analysis.
10	Comment recommended: Mathematics: Master (ana)

	ule nam Matt	-	al Mod	elling of Fluid Inte	rface	ic I					
Мо	dule no.			Workload		study	Duration	1	Freque	ency	
04-1	.0-0291		5 CP	150 h		•	1 Semest	ter	Irregul	-	
Lang	guage of	Instruct	ion		Pers	on responsib	le for the	Modu	ule		
Geri	man and	English			Prof	Dr. rer. nat.	Dieter Bo	the			
1	Course	Courses of the Module									
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0	286-vu		atical Modelling of Fl es	uid	-		Lecture and Exercise		3	
2	InterfacesExerciseStudy ContentBasic calculus on surfaces; two-phase and surface transport theorems; remarks on quasilinear free boundary problems. Derivation of two-phase integral balance equations for mass, momentum and species mass; derivation of local balances and interfacial jump conditions; modeling of surface tension, mass transfer, evaporation, condensation. Continuum thermodynamics of fluid interface; entropy balance; entropy principle and second law; linear and non-linear closures.										

3	Learning Outcomes
	Students learn to
	- describe the phenomena occuring at fluid interfaces
	- formulate the integral balances of two-phase fluid systems
	- formulate the differential form of the balance equations
	- formulate closure relations and transmission conditions
	 describe dissipative processes in single-component two-phase fluid systems
4	Requirements for Participation
	recommended: Analysis, Ordinary Differential Equations. Alternatively comparable
	prerequisites.
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a
	small number of potential participants. In this case, the exam can be taken in the form of an oral
	exam. The decision about the form of the exam is taken and communicated during the first two
	weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	R. Aris: Vectors, Tensors and the Basic Equations of Fluid Dynamics, Dover 1962.
	J.C. Slattery, L. Sagis, ES. Oh: Interfacial Transport Phenomena (2nd ed.), Springer 2006.
	D.A. Edwards, H. Brenner, D.T. Wasan: Interfacial Transport Processes and Rheology,
	Butterworth-Heinemann 1991.
10	Comment
	recommended: Mathematics: Master (ana)

Мо	dule nan	ne							
	Distr	ibution	theory						
Module no.Credit PointsWorkload04-10-5 CP150 h				Workload 150 h	Self-study 105	Duration			•
Language of Instruction					Person respons Prof. Dr. rer. na				
1	Course	s of the	Module						
	Course	no.	Course	name	Workload	Workload (CP)		of ning	Contact Hours per Week
	04-00-0	288-vu	Distribut	iotheory	0		Lectur Exercis		3
2			•	s, classes of distribu	utions, Fourier tr	ansformati	ion,		
3	Learning Outcomes Nach dem Besuch des Moduls - kennen sie die Begriffe topologischer Vektorraum und lokalkonvexer Raum - können sie mit Distributionen bzw. verallgemeinerten Funktionen rechnen und umgehen - können sie mit Fouriertransformation und temperierten Distributionen umgehen								
4	-		or Partic onenthe	ipation orie, Maßtheorie					
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, Technical Examination, Standard) • Module Examination (Study Examination, Study Examination, Passed / Not Passed)								
6	Require	ements o	on the A	ward of Credit Poin	ts				
7	Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)								

	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module BSc.Math. Wahlbereich, MSc.Math. Ergänzungsbereich, MSc.Phys. Ergänzungsbereich, LaG. Ergänzungsbereich
9	 Literature W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999. W. Rudin, Real and Complex Analysis, McGraw Hill, 3. Auflage 1987. J. Horváth, Topological Vector Spaces and Distributions, volume I, Addison- Wesley, Reading, Mass., 1966. L. Schwartz, Théorie des Distributions, Hermann, Paris, 1966. F. Treves, Topological Vector Spaces, Distributions and Kernels, Academic Press, New York, 1967.
10	Comment

Мос	lule nan	ne									
	Num	erical a	nd Stati	stical Meth	ods						
Module no. 04-10- 0300/de		Credit I	Points Workload 7 CP 210 h					Duration 1 Semester		1cy . semester	
-	Language of Instruction German					Pers	on respons	ble for th	e Modi	ule	
1	Course	s of the	Module								
	Course	no.	Course	name			Workload	(CP)	Form Teacl	•••	Contact Hours per Week
	04-00-0	081-vu	Numerio	al and Statisti	ical Met	hods 0			Lecture and 6 Exercise		6
2	Study C	Content									
	Numerical Analysis: unnumerical solution of linea systems, interpolation, numerical method in integration, systems of nonlinear equations, initial value problems for ODEs, computation of eigenvalues and eingevectors Statistics: basic concepts of statistics and probability theory, regression,										
				ns, methods o buted randor					5,		

3	Learning Outcomes Fähigkeit für grundlegende Aufgabenstellungen geeignete numerische Verfahren auszuwählen und anzuwenden. Fähigkeit statistische Auswertungen vorzunehmen, grundlegende Schätzverfahren und Testverfahren durchzuführen.
4	Requirements for Participation Mathematik 1 und Mathematik 2 und Mathematik 3
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module Für B.Sc.ETiT, B.Sc.MEC, B.Sc.CE, B.Sc.IST (PO 2007): Pflicht Für B.Sc.EPE, B.Sc.IST (bis PO 2006), B.Sc.iKT: Pflicht zusammen mit Mathematik 3 als Mathematik B Für M.Ed. Mathematik: PraktischeMathematik (für M.Ed.Math) mit 9 ECTS Für B.Sc.Inf mit 9 ECTS B.Sc.iKT auslaufend.
9	Literature Von Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch für Ingenieure II, Teubner Verlag Stuttgart;
10	Comment Verantwortlich: Herr Bothe (ana)

Module name							
Calcu	ılus III						
Module no.	Credit Points	Workload		Self-study		Duration	Frequency
04-10- 0301/de	4 CP		L20 h	-	45 h	1 Semester	Every 2. semester

	guage of Instruct	tion	Perso	on responsible fo	r the Module				
1	Courses of the Course no.	Module Course name		Workload (CP)	Form of Teaching	Contact Hours per			
	04-00-0121-vu	Calculus III (civil engineering)		0	Lecture and Exercise	Week			
2	Study Content 1) Differential equations: a) First order ordinary differential equations - existence and uniqueness, numerical methods; b) Second order ordinary differential equations - linear differential equations with constant and variable coefficients, systems of linear differential equations; c) Partial differential equations - classification, product ansatz, Fourier series; 2) Calculus of variations;								
3	Learning OutcomesIm Rahmen des für ihren Studiengang Erforderlichen sollen die Studierenden über Vertrautheit mit den einfachsten Typen von Differentialgleichungen erlangen.Die Studierenden besitzen die Fähigkeit, die wichtigsten rechnerischen Methoden in ihrer Bedeutsamkeit beurteilen und auf ingenieurtechnische Fragen, insbesondere im späteren Studium und Beruf anwenden zu können. Sie besitzen Grundvoraussetzungen, sich die benötigten mathematischen Kenntnisse selbst anzueignen.								
4	•	for Participation e in Mathe I und II							
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, Technical Examination, Standard) Requirements on the Award of Credit Points								
7	Grading Final Module Ex • Modul Standa	e Examination (Technical Ex	amina	tion, Technical Ex	amination, Weigh	t: 100%,			
		ra)							

9	Literature wird zu Beginn der VL bekannt gegeben.
10	Comment

Мо	dule nam	ne								
	PDEs	on Nor	nsmootł	n Domains						
Module no. 04-10- 0303/en		Credit Points 9 CP		Workload 270 h	Self-study 180 h		Duration 1 Semester		Frequency Every 2. semest	
Lan Eng	guage of lish	Instruct	ion			on responsib . Dr. rer. nat.				
1	Course	s of the	Module							
	Course no.		Course	urse name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	308-vu	PDEs on	Nonsmooth Domains		0		Lecture and 6 Exercise		6
	differer	ntial form	ns, diver	ng solutions, parabo gence equation, Sto cations to various p	kes e	quation oper	atior on		,	
3	Learning Outcomes After successfully passing this module students can - formulate and explain the central theorems and methods from the course - apply the methods to elliptic and parabolic partial differential equations and use them to solve adequate problems The students should be able to									
			•	ce of the results give mathematical result			ork of th	e cours	se	
4	-		f or Partic lysis or co	cipation omparable previous	knov	wledge				
5	Form o	f Examir	nation							

	Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
9	Literature will be announced in the lecture
10	Comment

Мо	dule nan	ne								
	Asyn	nptotic	s of linea	ar evolutionary e	quati	ons				
Module no. 04-10- 0304/de		Credit	Points 5 CP	Workload 150 h		study 105 h	Duratio 1 Semes		Frequency Every 2. semester	
	guage of man	Instruc	tion			on responsib . Dr. rer. nat.				
1	Courses of the Module									
	Course no. Course			name		Workload ((CP)	Form Teacł	•••	Contact Hours per Week
	04-10-0304-vu Asymptotics equations			tics of linear evolutionary 0		0		Lecture and Exercise		3
2	Study C	Content								
	Strongly continuous semigroups of linear operators, evolution equations, abstract Cauchy									auchy

	problems, asymptotic and stability
3	Learning Outcomes After completing the module, students can handle operator semigroups. They can handle abstract linear evolution equations and investigate long-term behaviour of solutions.
4	Requirements for Participation Funktionalanalysis
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module MSc.Math. specialisation, MSc.Math. supplementary area, MSc.Phys. supplementariy area, LaG. supplementary area
9	Literature Arendt, w., Batty, C.J., Hieber, M., Neubrander, F., Vector-valued Laplace transforms and Cauchy porblems. Birkhäuser, Basel etc., 2001. Davies, E.B., Obe-parameter semigroups. Academic Press London etc., 1980. Engel, KJ., Nagel, R., One-parameter semigroups for linear evolution equations. Springer, New York etc., 2000. Lunardi, A., Analytic semigroups and optimal regularity in parabolic problems. Birkhäuser, Basel, 1995. Pazy, A., Semigroups of linear operators and applications to partial differential equations. Springer, New York etc., 1992. Tanabe, H., Equations of evolution. Pitman, London etc., 1979.
10	Comment

				elling of Fluid Inte	rface	es II	[1			
-	dule no.	Credit F		Workload		Self-study Durati			Freque	-		
04-	10-0309		5 CP	150 h		105 h	1 Semes	ter	Irregul	ar		
	guage of		ion			on responsib			ule			
	man and English Prof. Dr. rer. nat. Dieter Bothe											
1	Course	s of the	Module									
	Course	no.	Course	name	Workload (CP)		CP)	Form of Teaching		Contact Hours per Week		
	04-10-0	309-vu	Mathematical Modelling of Fluid Interfaces II		uid	0		Lectur Exercis		3		
	 Study Content 1) Balance equations for multiphase fluid systems with interfacial mass; interface momentum and energy balance 2) Mass transfer across fluidic interfaces: chemical potential, interfacial jump conditions 3) Thermodynamically consistent modeling of dynamic three phase contact lines 											
3	Learning Outcomes Students learn to - describe advanced phenomena at fluid interfaces with interfacial mass - formulate the transmission and thermodynamical jump conditions for description of transportand transfer procces - describe the dissipative processes occuring at three phase contact lines							f transport				
4	-	nended:	or Partic Analysis	ipation , Ordinary Different	ial Ec	quations. Mat	hematica	ıl Mod	eling of	fluid		
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) 											
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an ora exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.											

	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature I. Müller: Thermodynamics, Pitman 1985 J.C. Slattery, L. Sagis, ES. Oh: Interfacial Transport Phenomena (2nd ed.),Springer 2006. D.A. Edwards, H. Brenner, D.T. Wasan: Interfacial Transport Processes and Rheology, Butterworth-Heinemann 1991.
10	Comment recommended: Mathematics: Master (ana)

Мос	lule nan	ne									
	Time	series	analysis	;							
Moc 04-1 0310	-	Credit F	Points 3 CP	Workload 90 h		- study 60 h		Duration 1 Semester		Frequency Every 2. semester	
	Language of Instruction German 1 Courses of the Module				Pers	on resp	oonsib	le for the	e Modu	ule	
1	Course	s of the	Module								
	Course	Course no. Course		name		Workload (CP)			Form of Teaching		Contact Hours per Week
	04-10-0	310-vl	Time ser	ries analysis		0			Lecture		2
2											
3	Learnin	g Outco	mes								
				1oduls können die S							
		-		deen und zentralen	-		ler Zei	treihenar	nalyse		
	im Rahi	men eint	acher Ze	eitreihenmodelle be	schre	iben,					

	Verantwortlich: Stochastik								
10	Comment								
9	Literature Schlittgen, R., Streitberg, B.H.J.: Zeitreihenanalyse. Oldenbourg. Brockwell, P.J., Davis, R.A.: Introduction to Time Series and Forecasting. Springer. Falk et al.: A First Course on Time Series Analysis. http:#47;#47;statistik.mathematik.uni-wuerzburg.de#47;timeseries#47;								
8	Usability of the Module								
7	 Grading Final Module Examination: Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) 								
6	Requirements on the Award of Credit Points								
	 Final Module Examination: Module Examination (Study Examination, Study Examination, Passed / Not Passed) Module Examination (Technical Examination, Technical Examination, Standard) 								
5	Form of Examination								
4	Requirements for Participation Einführung in die Stochastik, Probability Theory#47;Wahrscheinlichkeitstheorie								
	-ausgewählte Methoden der Zeitreihenanalyse mathematisch analysieren und die dabei erlernten Beweistechniken auf verwandte Fragestellungen übertragen.								

Module nan	Module name										
Class	Classical and Non-Classical Model Theory										
Module no.	Credit Points	Workload	Self-study		Duration	Frequency					
04-10- 0311/en	9 CP	270			1 Semester	Irregular					

	guage of Instruc	tion		son responsible for					
Eng	lish		Prof. Dr. rer. nat. Martin Otto						
1	Courses of the	Module		1		I			
	Course no. Course name		Workload (CP)		Form of Teaching	Contact Hours per Week			
	04-10-0311-vu	Classical and Non-Classical Mo Theory	odel	0	Lecture and Exercise	6			
2	Study Content comparing logics: first-order and other logics; compactness, types and saturation properties, Ehrenfeucht–Fraïssé games and Lindstroem theorems; tractable theories and tractable mod- preservation and expressive completeness; algorithmic issues and decidability; themes in fin and algorithmic model theory								
3	Learning Outcomes Students understand and are able to apply and compare core notions, methods and results of classical and of finite model theory treated in the course. They have developed an advanced level of understanding of classical as well as non-classical logical systems in terms of expressiveness, links between syntax and semantics and algorithmic issues, which enables them to extend their knowledge in this field and allows them to conduct related research under supervision.								
4	recommended	for Participation Introduction to Mathematic ogic as taught in CS program		ogic.					
5			amin	ation, oral / writter	n Examination, Du	uration 90			
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an ora exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.								
6	Requirements Passing the Fac	on the Award of Credit Poin hprüfung	nts						
7	Grading Final Module E • Modul Standa	e Examination (Technical Ex	amin	ation, oral / writter	n Examination, W	eight: 100%,			

8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics							
9	Literature							
	Cori/Lascar: Mathematical Logic							
	Chang/Keisler: Model Theory							
	Hodges: Model Theory							
	Poizat: A Course in Model Theory							
	Ebbinghaus/Flum: Finite Model Theory							
	Grädel et al (eds): Finite Model Theory and Its Applications							
10	Comment							
	recommended: Mathematics: Master (log)							
	Due to content overlap, this course cannot be combined with Model Theory or Finite Model							
	Theory.							

Мо	dule nan	ne									
	Gam	e Theoi	ry						-		
Module no. 04-10- 0312/de		Credit	Points Workload 5			Self-study Duratio 105 h 1 Seme		-	-	Frequency Irregular	
Language of Instruction German					r son responsib of. Dr. rer. nat.			ule			
1	Course	s of the	Module								
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0320-vu		Game Theory			0		Lecture and Exercise		3	
 Study Content Cooperative game theory: coalitions, solution concepts, stable sets, core, Shapley value, games. Non-cooperative game theory: Sequential and strategic games, two-person and n-perso games, zero-sum and non-zero-sum games, discrete and continuous games. Various con solution of a game (e.g. Nash equilibrium). Fixed point theorems (e.g. Brouwer). Existence results (e.g. minimax theorem) and impossibility theorems. Algorithmic aspects. Application 					rson concepts o tence						
3	Learning Outcomes Students are familiar wi understand fundament They can illustrate and			al (solution) conce	epts in	cooperative o	r noncoo	perativ	ve game	theory.	

	models of simple applications. They are able to prove and apply mathematical theorems to
	analyze games and to judge the results with respect to practical purposes. They can solve certain classes of games numerically.
4	Requirements for Participation recommended: Analysis, Linear Algebra
5	Form of Examination Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
	Studienleistung: Usually this means that the student successfully completes a certain proportion of the homework assignments. The precise proportion of necessary assignments and the marking scheme will be communicated by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Osborne: An Introduction to Game Theory Forg, Szép und Szidarovszky: Introduction to the Theory of Games Krabs: Spieltheorie: Dynamische Behandlung von Spielen Berninghaus, Ehrhart und Güth: Strategische Spiele
10	Comment recommended: Mathematics: Bachelor year 3 (opt)

Мо	dule nam	ne									
	Riem	ann Su	rfaces								
04-1	-	Credit F	Points 5 CP	Workload 150 h	Self-study 105 h	Duration 1 Semest		Freque Every 2	ncy . semester		
	4/de	Instruct			Derson rosnonsik	la far tha	Madu				
	guage of man	mstruct	.1011		Person responsible for the Module Prof. Dr. rer. nat. Jan Hendrik Bruinier						
1	Course	s of the	Module		ļ						
	Course	no.	Course	name	Workload (-	Form of Teaching		Contact Hours per Week		
	04-10-0	04-10-0314-vu Riemann Surfaces		n Surfaces	0		Lecture and Exercise		3		
2		in surfac		morphic maps, the f erential forms, cohc			-		-		
3	Studen study o		stand the ometry o	e concept of a Riem f Riemannian surfa							
4	-		or Parti o ie Algebr	c ipation ra, Funktionentheor	ie						
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Study Examination, Passed / Not Passed) Module Examination (Technical Examination, Technical Examination, Standard) 							·			
6	Require	ements o	on the A	ward of Credit Poin	ts						
7	Grading Final M	-	aminatio	on:							
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed) 										

	• Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module
	Für B.Sc.Math, B.Sc.Math (bilingual), B.Sc.MCS, B.Sc.WiMa, B.Sc.ME:
	Wahlp#64258;ichtbereich. Für M.Sc.Math: Vertiefungsbereich. Für M.Sc.WiMa: Ergänzungsbereich.
9	Literature
	O. Forster: Riemannsche Flächen (Riemann surfaces)
	E. Freitag: Funktionentheorie II
	K. Lamotke: Riemannsche Flächen
	H. M. Farkas and I. Kra: Riemann surfaces
10	Comment

Distr	ibution	s and Ha	armonic Analysis	ŀ		[r		
LO-	Credit Points 5 CP		Workload 150 h	Self-study 105 h		Duration 1 Semester		Frequency Every 2. semeste		
Language of Instruction					on responsib	le for the	Modu	le		
man				Prof	. Dr. rer. nat.	Matthias	Hiebe	r		
Courses of the Module										
Course no.		Course	name	Workload (CP)		CP)	Form of Teaching		Contact Hours per Week	
04-10-0316-vu		Distributions and Harmonic Analysis		0			Lecture and Exercise		3	
Study Content Distribution classes, Fourier transformation, Fundamental solutions, Sobolevspaces, Integral operators										
Learning Outcomes After completing the module, students will be able to deal with distributions and Sobolev spaces. They understand distributions, Sobolev spaces and the basics of harmonic analysis.										
	dule no. 10- 6/de guage of man Course Course 04-10-0 Study C Distribu operato After co	dule no. Credit I 10- 6/de 6/de guage of Instruct guage of Instruct man Courses of the Course no. 04-10-0316-vu 04-10-0316-vu Study Content Distribution cla operators Learning Outco After completir Distribution	dule no. Credit Points 10- 5 CP 6/de 5 CP guage of Instruction man Courses of the Module Course no. Course 04-10-0316-vu Distribut O4-10-0316-vu Distribut Study Content Distribution classes, Fou Distribution classes, Fou operators Learning Outcomes After completing the mode	Credit Points Workload 10- 5 CP 150 h guage of Instruction man Instruction Courses of the Module Course no. Course name 04-10-0316-vu Distributions and Harmonic Analysis Study Content Distribution classes, Fourier transformation operators Learning Outcomes After completing the module, students will	dule no. 10- 6/de Credit Points 5 CP Workload 150 h Self- guage of Instruction man Pers Prof Courses of the Module Prof Course no. Course name 04-10-0316-vu Distributions and Harmonic Analysis Study Content Distribution classes, Fourier transformation, Fun operators Learning Outcomes After completing the module, students will be ab	dule no. Credit Points Workload Self-study 10- 5 CP 150 h 105 h guage of Instruction Person responsib man Prof. Dr. rer. nat. Courses of the Module Course no. Course name 04-10-0316-vu Distributions and Harmonic 0 Study Content Distributions and Harmonic 0 Study Content Distributions and Harmonic 0 Analysis Learning Outcomes After completing the module, students will be able to deal with	dule no. Credit Points Workload Self-study Duration 10- 5 CP 150 h 105 h Duration guage of Instruction Person responsible for the man Prof. Dr. rer. nat. Matthias Courses of the Module Points Course no. Course name Workload (CP) 04-10-0316-vu Distributions and Harmonic 0 Study Content Distributions and Harmonic, Analysis 0 Study Content Distribution, Fundamental solutions, Solution	dule no. Credit Points Workload Self-study Duration 10- 5 CP 150 h 105 h 105 h 1 Semester guage of Instruction Person responsible for the Module Prof. Dr. rer. nat. Matthias Hiebe Courses of the Module Course no. Course name Workload (CP) Form Teach 04-10-0316-vu Distributions and Harmonic 0 Lecture Study Content Distributions and Harmonic, Analysis 0 Lecture Study Content Distribution, Fundamental solutions, Sobolever, operators Sobolever, Sobolever	dule no. Credit Points Workload Self-study Duration Frequent 6/de 5 CP 150 h 105 h 105 h 1 Semester Every 2. guage of Instruction Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber Courses of the Module Courses of the Module Course no. Course name Workload (CP) Form of Teaching 04-10-0316-vu Distributions and Harmonic 0 Lecture and Exercise Study Content Distribution classes, Fourier transformation, Fundamental solutions, Sobolevspaces, In operators Analysis Learning Outcomes After completing the module, students will be able to deal with distributions and Sobolevspaces Sobolevspaces	

5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	BSc.Math. Wahlbereich, MSc.Math. Ergänzungsbereich, MSc.Phys. Ergän-
	zungsbereich, LaG. Ergänzungsbereich
9	Literature
	W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999.
	W. Rudin, Real and Complex Analysis, McGraw Hill, 3. Auflage 1987.
	L. Schwartz, Théorie des Distributions, Hermann, Paris, 1966.
	W. Walter, Distributionen
	L. Evans, Partial Differential Equations
10	Comment

Мо	dule nan	ne									
	Mark	ov cha	ins and i	interacting sto	cha	stic s	/stems				
Module no. 04-10- 0318/deCredit Points 9 CPWorkload270 h						Self-s	study Duration 180 h 1 Semester			Frequency Every 2. semester	
Language of Instruction German 1 Courses of the Module					Person responsible for the Module Prof. Dr. rer. nat. Volker Martin Betz						
	Course	Course no. Course name				Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0	04-10-0318-vu Markov chains and interacting stochastic systems				g ()		Lecture Exercis		6

2	Study Content Discrete time Markov chains: stationary distributions, recurrence and transience, convergence towards stationary distributions, variation distance, mixing time, coupling; Examples: random walks on groups, birth and death chains, urn models, card shuffling,
	Particle systems: Curie-Weiss model, Ising model, thermodynamic limit, phase transitions.
3	Learning Outcomes Participants get to know important aspects of discrete time Markov chains, the most important and most basic model going beyond sums of independent random variables. Important general notions and techniques like variation distance and coupling are introduced in that context. They learn about some of the most fundamental models and building blocks of modern proabbility and see the basics of statistical mechanics. At the end of the course, they will be able to read advanced textbooks and basic research articles in discrete probability and mathematical statistical mechanics.
4	Requirements for Participation Analysis, Lineare Algebra und Wahrscheinlichkeitstheorie.
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module MSc.Math. Vertiefung, MSc.Math. Ergänzungsbereich, BSc.Math. Wahl- pflichtbereich, MSc.Phys. Ergänzungsbereich
9	Literature D. A. Levin, Y. Peres, E. L. Wilmer: Markov Chains and Mixing Times; AMS publishing (2009).
1	J. R. Norris: Markov chains; Cambridge University Press, (1998).

	T. M. Liggett: Interacting Particle Systems, Springer Classics in Mathema- tics (2005).
10	Comment

Мо	dule nam	ne											
	Asyn	nptotics	of evol	ution equations									
Module no. Credit Points Workload					Self-	Self-study D		า	Freque	ncy			
04-10-0319 5 CP 150 H				105 h 1 Semes			ster Irregular						
Language of Instruction					Pers	on responsib	le for the	e Modu	ıle				
German and English					Prof.	Dr. rer. nat.	Matthias	Hiebe	r				
1	Course	Courses of the Module											
	Course no. Course			name		Workload (0	CP)	Form Teach		Contact Hours per Week			
	04-10-0319-vu Asympto Equation			ntics of Evolution		0		Lecture and Exercise		3			
2 3	Study Content Stability theory of linear semigroups, Lyapunov method, dichotomy, stable manifolds Learning Outcomes Students learn to apply stability theory, dichotomy, and invariant manifolds												
4	Requirements for Participation recommended: Functional Analysis												
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two 												
6	weeks of the lecture, based on the prospective number of students taking the exam. Requirements on the Award of Credit Points Passing the Fachprüfung												

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Engel, KJ., Nagel, R., One-parameter semigroups for linear evolution equations. Springer, New York etc., 2000. Arendt, w., Batty, C.J., Hieber, M., Neubrander, F., Vector-valued Laplace transforms and Cauchy porblems. Birkhäuser, Basel etc., 2001. Chicone: Ordinary Differential Equations and Applications.
10	Comment recommended: Mathematics: Master (ana)

Mo	dule nan	ne								
	Varie	ety of m	athema	itical tasks (online	e)					
04-1	dule no. 10- 2/de	Credit F	Points 2 CP	Workload 60 h		Self-study Duratio 60 h 1 Semes			Freque Every 2	e ncy 2. semester
	guage of man	Instruct	ion			on responsib Dr. phil. nat			ule	
1	Course	s of the	Module							
	Course no. Course		name	Workload		· · · ·		of hing	Contact Hours per Week	
	04-10-0	322-vl	Variety o (online)	of mathematical tasks	0 Lecture				e	0
2	Study Content Results of studies to describe competencies of teachers, analysis of tasks in old and new school books, examples from the PISA- and TIMSS-tests, tasks in examinations, tasks for gifted students for the "Tag der Mathematik" or other competitions									
3	Learning Outcomes Die Studierenden können das Lernpotenzial unterschiedlicher Aufgabenformate an Beispielen in Lern- und Testsituationen beschreiben und entwickeln									

	Problemlösekompetenz. Schulmathematische Kenntnisse werden in Erklärungssituationen vertieft und vernetzt.
4	Requirements for Participation
	Fachdidaktisches Proseminar (auch parallel belegbar)
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Study Examination, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	Stand SoSe2012: Im Wahlpflichtbereich als Alternative zur Schulpraktischen Erprobung (2 CP) in Verbindung mit dem Fachdidaktischen Projekt
9	Literature
	Online-Skript, Ergebnisse und Materialien von Schulleistungsstudien, Abiturprüfungen und Mathematikwettbewerben, gängige Lehrbücher
10	Comment
	In der Novelle des Studien- und Prüfungsplanes (gültig ab WS 2012#47;13) verwendbar als Pflichtteilmodul im Modul "Grundlagen des Lehrens und Lernens von Mathematik"(10 CP);
	Für Studierende älterer Studienordnungen ersetzt dieses Teilmodul die für das Projektmodul früher geforderten 2 CP Schulpraktische Studien.

Module nan	Module name					
Adva	nced Applied P	roof Theor	у			
Module no. 04-10- 0324/en	Credit Points 5 CP	Workload	150 h	Self-study 105 h	Duration 1 Semester	Frequency Irregular
Language of English	Instruction			Person responsib Prof. Dr. phil. nat		

1	Courses of the	Module			
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	04-10-0324-vu	Advanced Applied Proof Theory	0	Lecture and Exercise	3
2	together with t the Gödel funct analysis and the hyperbolic and these technique theory and ergo	continuation of the course `Basic he latter with the 4+2 hours cour cional interpretation of full analys eir extensions to systems based of normed spaces. In applications to es to analyze proofs in the areas odic theory. These applications an w qualitative uniformity results fr	se `Applied Proof Theo sis (Spector), monoton on classes of abstract (o concrete proofs in m of approximation theo re concerned with the	ory'. The cours e interpretation nonseparable) nathematics we ory, metric fixed extraction of e	e develops ons of metric, e apply d point
3	of bar recursion 2) have experien new base types metatheorems; 3) can on their the area of non	Spector's extension of Gödel's fur as well as its monotone version nce with the inclusion of abstract into the functional interpretatio	; t metric, hyperbolic ar n and understand the o suitable noneffective	nd normed stru corresponding e proofs, in par	ictures as logical ticular in
4	-	for Participation Basic Applied Proof Theory			
5	min, Sta Fachprüfung: U		of a written test, excep	ot when there	are only a
6	exam. The decis weeks of the le Requirements	sion about the form of the exam cture, based on the prospective r on the Award of Credit Points	is taken and communi	cated during tl	he first two
7	Passing the Fac Grading Final Module Ex				

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Kohlenbach, U.: Applied Proof Theory: Proof Interpretations and Their Use in Mathematics. Springer Monograph in Mathematics, xx+536pp., 2008
10	Comment
	recommended: Mathematics: Master (log)
	Due to content overlap, this course cannot be combined with Applied Proof Theory.

Мос	dule nan	ne									
	Com	putabili	ty in An	alysis		•					
Mod 04-1 032					.50 h		elf-study Duration 105 h 1 Semester			Frequency Irregular	
-	guage of	Instruct	ion				on responsib . Dr. phil. nat				
1	Course	s of the	Module			1					
	Course no. Course name			name			Workload ((CP)	Form Teach		Contact Hours per Week
	04-10-0	325-vu	Comput	ability in Analysi	S		0		Lectur Exercis		3
2	incomp	tions an utable r	eal numl	of discrete and pers, sequence vity (TTE); Com	s, fur	nctior	is, relations, a	and sets;	Repres	sentation	is and
3	Learning Outcomes Students can distinguish heuristic numerical arguments from provably correct algorithms. They can refine existence theorems from analysis in terms of computability statements and also know examples of noncomputable problems in analysis. They can connect computability with topological properties.										
4	-		or Parti o Introduc	c ipation ction to Compu	utabil	ity Th	eory				

	Alternatively: Logic as taught in CS programmes
5	Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Weihrauch: Computable Analysis (2000)
10	Comment recommended: Mathematics: Master (log)

Мо	dule nam	ne								
	Geor	netric C	ombina	torics						
Мо	dule no.	Credit P	oints	Workload		Self-study	Duration		Freque	ncy
04-	10-0327		5 CP		150 h	105 h	1 Semest	er	Irregula	r
Lan	guage of	Instruct	ion			Person responsi	ble for the	Modu	le	
Ger	man and	English				Dr. rer. nat. And	reas Paffer	holz		
1	Course	s of the I	Module							
	Course	no.	Course	name		Workload	CP)	Form (Teach		Contact Hours per Week

	04-10-0327-vu	Geometric Combinatorics	0		ecture and xercise	3
2	geometry of nu algorithms in th	atures recent topics in geom mbers, polyhedral theory, E nese fields. It is a goal to rela e of geometric concepts.	hrhart theory,	toric geometry	and introdu	ced key
3	from the field o apply them and	mes on of the module students k of geometric combinatorics a l can assess their limitations pervised research.	and their relation	on to combinat	orial optimiz	ation, can
4	-	for Participation Introduction to Optimizatio	on, preferably a	lso Discrete Op	otimization	
5	min, Sta Fachprüfung: U small number o exam. The decis		orm of a writte his case, the ex xam is taken a	en test, except v am can be take nd communicat	when there a en in the forr ted during th	ire only a n of an oral
6	Requirements Passing the Fac	on the Award of Credit Poir hprüfung	ıts			
7	Grading Final Module Ex Module Standar	e Examination (Technical Ex	amination, ora	l / written Exan	nination, We	ight: 100%,
8	Usability of the B.Sc Mathemat	e Module ik, M.Sc. Mathematik, M.Sc.	Mathematics			
9	Rekha Thomas, Alexander Barv Jesus De Loera, Theory of Discre	nas und Robert Weismantel, Lectures in geometric comb inok, A Course in Convexity, Raymond Hemmecke, Matt ete Optimization, SIAM (201 s, Gröbner bases and conves	pinatorics, AMS AMS (2002) hias Köppe, Al 2)	gebraic and Ge		

-	dule nam Optii		n in Trar	nsport and Traffic						
Module no. Credit Points Workload					Self	-study	Duration	า	Freque	ncy
04-	10-0330		5 CP	150 h		105 h	1 Semes	ter	Irregula	ar
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ule	
Ger	rman and	English			Prof	. Dr. rer. nat.	Marc Pfe	tsch		
1	Course	s of the I	Vodule							
	Course	no.	Course	name		Workload ((CP)	Form Teacł	-	Contact Hours per Week
	04-10-0	330-vu	Optimiza Traffic	ation in Transport and	I	0		Lecture Exercis		3
	- model inequal - Comp - Optim - model	ities, etc utationa ization r s for car	niques (s .) I comple nethods traffic (d	set partitioning, veh xity - column generatio dynamic flows, equi tions will be addres	n libria	, Braess-para	doxon et		v, Chvata	al-Gomory
3	After at transpo) and Student	ort. They will be a ts are ab	this cour will mas ble to ind le to con	rse, studens will kno ter fundamental op dependently set up itextualize subject r ethically and respon	otimiz optir natte	ation method mization mod r within the s	ls (model els and so	ling, co plution	olumn ge 1 method	eneration, ds.
4	-		or Partic Introduc	ipation tion to Optimizatio	n; us	eful: Discrete	Optimiza	ition		
5		f Examin odule Ex	a tion aminatio	on:						

	 Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature lecture notes
10	Comment recommended: Mathematics: Master (opt)
L	

Mo	dule nan	ne									
	Stock	nastic p	rocesse	S							
Module no.Credit Points04-10-9 Cl0332/de		Points 9 CP	Workload	270 h		study 180 h	Duratio			e ncy 5. semester	
	guage of man	Instruct	tion				on responsib . Dr. rer. nat.			le	
1	Courses of the Module										
	Course	no.	o. Course name			Workload ((CP)	Form of Teaching		Contact Hours per Week	
	04-10-0	332-vu	Stochast	ic processes			0		Lectur Exercis		6
2	Study C		y of stocł	nastic process	ses: pa	th spa	ace, filtration	s, exister	nce		

	 Gaussian processes Markov processes martingales in continuous time jump processes: renewal processes, Poisson processes Brownian motion: path properties stochastic integal Ito formula Girsanov transformation stochastic differential equations
3	Learning Outcomes - get to know the most important results about stochastic processes in continuous time and about stochastic differential equations
	 get to know the most important examples of stochastic processes in detail, like Brownian motion, Poisson process
	 understand the most important techniques, like martingale arguments, stopping times, relations to functional analysis
	 lay the foundations for more advanced topics in stochastic analysis or many-particle systems
4	Requirements for Participation Analysis, Lineare Algebra und Wahrscheinlichkeitstheorie. Grundkenntnisse in Funktionalanalysis sind sehr hilfreich.Fachdidaktisches Proseminar (auch parallel belegbar)
5	Form of Examination Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module MSc.Math. Vertiefung, MSc.Math. Ergänzungsbereich, BSc.Math. Wahlpflichtbereich, MSc.Phys. Ergänzungsbereich
9	Literature Klenke: Wahrscheinlichkeitstheorie

	Mörters and Peres: Brownian motion Oksendal: stochastic differential euqations
10	Comment Verantwortlich: Herr Aurzada (sto)

1110	dule nam Math	-	al Mod	elling of Chemical	lv Read	tive Flows	5							
Мо	dule no.			Workload	Self-st		Duratio	n	Freque	ency				
04-	10-0335		5 CP	150 h		<i>.</i> 105 h	1 Semes	ter	Irregular					
Lan	guage of	Instruct	tion		Perso	n responsib	le for the	e Modu	ule					
Ger	rman and	English			Prof. [Dr. rer. nat.	Dieter Bo	othe						
1	Course	Courses of the Module												
	Course	no.	Course	aname natical Modelling of ally Reactive Flows		Workload ((CP)	Form of Teaching		Contact Hours per Week				
	04-10-0	335-vu				0		Lecture and Exercise		3				
				ell-Stefan equations on via quasi-steady-				he prir	nciple of	fdetailed				
3	Studen - derive - derive - under - derive - descri - under	e differen stand th e thermo be chem stand th	to es for mu ntial bala e entrop odynami nical reca e conne	Ilti-component-flow ince equations from by principle cally consistent mod ition kinetics ctions between deta ction between Fick o	n integra dels for ailed ec	flows as di Juilibrium a	nd the er	ntropy	principl					
4	•		for Partic	cipation , Ordinary Different	tial Fau	ations Alto								

5	Form of Examination
_	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a
	small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two
	weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	V. Giovangigli: Multicomponent Flow Modeling, Springer 1999.
	S. R. De Groot, P. Mazur: Non-Equilibrium Thermodynamics, Dover 1983. R. Taylor, R. Krishna: Multicomponent Mass Transfer, Wiley 1993.
10	Comment
	recommended: Mathematics: Master (ana)

Мо	dule nan	ne								
	Math	nematic	al Foun	dations of Qua	antu	m Mechanics (f	or Physic	cists)		
04-	dule no. 10- 7/de	Credit F	Points 5 CP	Workload 15	60 h	Self-study 105 h	Duration 1 Semes	-	Freque Every 2	e ncy 2. semester
	guage of man	Instruct	ion			Person responsit	ole for the	e Modu	ule	
1	Course	s of the l	Module							
	Course	Course no. Course		e name		Workload (CP)	P) Form Teach		Contact Hours per Week
	04-10-0	328-vu	Mathem	atical Foundation	ns of	0		Lecture	e and	3

	Quantum Mechanics Exercise
2	Study Content Classical physics versus quantum mechanics, Bell's inequality.
	The axioms of quantum mechanics and their consequences.
	Observables and self-adjoint operators.
	Stone's Theorem and time dependent Schrödinger Equation.
	Composed systems and tensor products.
	Entangled states and quantum information.
3	Learning Outcomes
	Nach dem Besuch des Moduls können die Studierenden
	das mathematische Modell der Quantenmechanik erläutern und interpretieren,
	physikalische Annahmen von ihren mathematischen Konsequenzen unterscheiden,
	die Angemessenheit mathematischer Methoden in der Behandlung quantenmechanischer Probleme bewerten,
	die fundamentalen Unterschiede zwischen klassischer Physik und Quantenmechanik erläutern.
4	Requirements for Participation
	Die Vorlesungen der ersten beiden Studienjahre des entsprechenden Studienganges.
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Study Examination, Weight: 100%, Passed / Not Passed)
8	Usability of the Module Nichtphysikalisches Ergänzungsfach oder fachübergreifende Lehrveranstaltung.
9	Literature J. v. Neumann: Mathematische Grundlagen der Quantenmechanik

	M. Reed, B. Simon: Methods of Modern Physics I.
	G.W. Mackey: Mathematical Foundations of Quantum Mechanics.
	M. Nielsen, I. Chuang: Quantum Computation and Quantum Information.
10	Comment
	Verantwortlich: NF Kümmerer

Mo	intro	duction							T	
	Module no. Credit Points Workload		Workload	Self-	study	Duratio	n	Freque	ncy	
04-: 033			5 CP			105 h	1 Semester		Irregular	
0338/de 5 Ci 150 Language of Instruction					Dors	on responsib	le for the	Modu	مار	
	man	mstruct				. Dr. rer. nat.				
1	Course	s of the	Module		<u> </u>					
	L Courses of the N Course no.		Course	name		Workload ((CP)	Form Teacl	-	Contact Hours per Week
	04-10-0	04-10-0338-vu Intro Theo		tion to Axiomatic Set	0		Lecture and Exercise		3	
	explain today. ' about t	how thi We intro heir arit	s system duce the hmetics.	age and the axioms allows one to form e notions of ordinal Furthermore we dis emma and the Well	ulate and c scuss	and formaliz ardinal numb the Axiom of	e mather pers and p Choice a	natics prove s	as it is kr some bas	nown sic facts
	Learning Outcomes Students master the language and basic methods of set theory like transfinite induction and recursion and basic cardinal (in)qualities. Moreover, they can recognize when the Axiom of Choice is used.									
3	Studen [.] recursio	ts maste on and b	r the lan				•			

• Module Examination (Technical Examination, oral / written Examination, Standard)
Module Examination (Study Examination, Special Form, Passed / Not Passed)
Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
Requirements on the Award of Credit Points
Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
Passed)
Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
Literature Lecture notes provided online. Further reading: Moschovakis "Notes on Set Theory" (Springer 2006)
Comment recommended: Mathematics: Bachelor year 3 (log)

Мос	Module name											
	Introduction to Axiomatic Set Theory											
Module no.Credit PointsWorkload04-10-5 CP150 h					Self-studyDurationFrequency105 h1 SemesterIrregular				•			
Lang Engl		Instruct	ion					•	le for the Thomas S			
1 Courses of the Module												
	Course	no.	Course	name			Work	load (C	CP)	Form Teach	-	Contact Hours

					per Week
	04-10-0338-vu	Introduction to Axiomatic Set Theory	0	Lecture and Exercise	3
2	we explain how today. We intro about their arit Furthermore w	he language and the axioms of this system allows one to form oduce the notions of ordinal and hmetics. e discuss the Axiom of Choice a Well Ordering Theorem.	nulate and formalized cardinal numbers	ze mathematics as it s and prove some ba	is known asic facts
3		omes er the language and basic metho basic cardinal (in)qualities. More	-		
4	-	for Participation tical foundations in Analysis and	d Linear Algebra		
5	 Modul Fachprüfung (T when there are taken in the for 	xamination: e Examination (Technical Exam e Examination (Study Examinat echnical Examination): Usually conly a small number of potent m of an oral exam. The decision during the first two weeks of th	ion, Special Form, the exam is taken ial participants. In n about the form c	Passed / Not Passed in form of a written this case, the exam of the exam is taken	d) test, except can be and
6	-	on the Award of Credit Points hprüfung; passing the Studienle	eistung is a prereq	uisite for taking the	
7	Standa	e Examination (Technical Exam rd) e Examination (Study Examinat			-
8	Usability of the Mathematics: E	e Module Bachelor year 3 (log)			

9	Literature Lecture notes provided online. Further reading: Moschovakis Notes on Set Theory (Springer 2006)
10	Comment

Мос	dule nam	-								
Мос		I.A Con Credit F	-	Workload	Self-study		Duration		Frequency	
04-1	.0-0339		5 CP	150 h		105 h	1 Semes	ter	Irregula	ır
Lang	guage of	Instruct	ion		Pers	on responsib	le for th	e Modu	ule	
Gerr	man and	English			Prof	. Dr. rer. nat.	Matthias	Hiebe	r	
1	Course	s of the I	Module					_		
	Course no. Course		name	name		Workload (CP)		of ning	Contact Hours per Week	
	04-10-0	339-vu	PDE II.A	Complex Fluids		0		Lectur Exercis		3
2		pment a		tical treatment of fl astic fluids.	uid m	nodels with co	omplex st	ress te	ensors, e.	.g.
3	Studen - under - develo - are ab	stand an op an ad le to ext	id are ab vanced l end thei	le to apply the notion evel of understandi ir knowledge in this rvised research in th	ng of field	complex fluid		eated i	in the co	urse
4	-	ements f nended:		cipation nal Analysis, Partial	Diffe	rential Equati	ons l			
5		f Examir odule Ex		on:						
	•	Module	e Examir	nation (Technical Ex	amina	ation, oral / w	vritten Ex	aminat	tion, Sta	ndard)
				Examination): Usua mall number of pote	•					•

	taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature lecture notes
10	Comment recommended: Mathematics: Master (ana) Builds on "Partial Differential Equations I". Upon approval, contents of two PDE II.X-courses may replace "Partial Differential Equations II" and can be combined with the content from "Partial Differential Equations I" as an "Advanced Course in Analysis". Combinations of two or more PDE II.X-courses as additional courses require approval, too.

Module name												
	Interacting particle systems and statistical mechanics											
Module no.Credit PointsWorkload04-10-9 CP270 h		Self-study 180 h		-	Frequency Every 2. semester							
Lang Engl 1	guage of Instruction lish Courses of the Module					Person responsible for the Module Prof. Dr. rer. nat. Volker Martin Betz						
	Course no. Course			name			Workload ((CP)	Form Teach		Contact Hours per Week	
	04-10-0341-vu Interacting partie statistical mecha			- ·	ms ar	nd	0		Lecture Exercis		6	

2	Study Contant										
2	Study Content Continuous time Markov chanis and jump processes, their generator and associated semigroup. Feller processes and their generator.										
	Interacting particle systems: important examples like the contact process, spin systems and the										
	exclusion process.										
	Correlation inequalities, monotonicity and coupling arguments, graphical representations,										
	duality.										
3	Learning Outcomes										
-	Students will get to know some basic theory of continuous time Markov jump processes.										
	They will learn the infinitesimal description of these processes in terms										
	of generators, and how to reconstruct transition semigroups and eventually the										
	process from its generator.										
	They will then be introduced to the active field of interacting particle systems.										
	These are stochastic processes where many relatively simple										
	small parts interact and create effects on a greater scale - examples are spreading										
	of diseases or opinions, or magnetization in matter. Models covered will include										
	the ferromagnetic Ising model (modelling magnetism), the contact process (modeling										
	spreading of diseases), and the simple exclusion process.										
	In the second part of the lecture, we will cover the foundations of statistical										
	mechanics. Mathematically this is to study the equilibrium distributions of										
	some of the particle systems above. We will introduce the thermodynamic limit										
	and the thermodynamic quantities such as pressure and free energy, and										
	their significance for the bulk properties of the interacting particle system.										
4	Requirements for Participation										
	Analysis, Lineare Algebra und Wahrscheinlichkeitstheorie.										
	Grundkenntnisse in Funktionalanalysis sind sehr hilfreich.										
5	Form of Examination										
	Final Module Examination:										
	Module Examination (Technical Examination, Technical Examination, Standard)										
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)										
6	Dequivements on the Award of Credit Deinte										
6	Requirements on the Award of Credit Points										
7	Grading										
	Final Module Examination:										
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard) 										
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed) 										

8	Usability of the Module MSc.Math. Vertiefung, MSc.Math. Ergänzungsbereich, BSc.Math. Wahlpflichtbereich, MSc.Phys. Ergänzungsbereich
9	Literature
	Klenke: Wahrscheinlichkeitstheorie (for the basics) Liggett: Continuous time Markov Processes: an introduction;
	(the first two parts of the lecture will follow chapters 2-4 there).
	Liggett: Interacting particle systems (a much more in depth book for some background reading).
	(a much more in depth book for some background reading).
	Georgii: Gibbs measures und phase transitions
	(we will introduce some of the material there in the last third of the course, but with some significant simplifications).
10	Comment
	Verantwortlich: Herr Betz (sto)

Mod	lule nam	ne									
	Harm	nonic Aı	nalysis								
Мос	lule no.	Credit F	Points	Workload		Self-	study	Duratior	n Frequen		су
04-1	.0-0342		9 CP		270 h		180 h	1 Semes	ter	Irregula	r
Lang	guage of	Instruct	ion			Pers	on responsib	le for the	Modu	ıle	
Gerr	man and	English				Prof.	Dr. rer. nat.	Matthias	Hiebe	r	
1	Course	s of the	Module						_		
	Course	no.	Course	name			Workload (CP)	Form of		Contact Hours
									Teaching		per Week
	04-10-03	342-vu	Harmon	ic Analysis			0	Lecture and 6 Exercise		6	
2	functio	transfor	eron-Zyg	n Lebesgue-sp mund theory o							
3	Studen - under	stand ar	id are ab	le to apply the evel of unders					eated i	n the cou	urse

	- are able to extend their knowledge in this field
	- are able perform supervised research in this field
4	Requirements for Participation
	recommended: Functional Analysis
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	E.M. Stein Haremonic Analysis, Princeton University Press 1993
	L. Grafakos: Classical Fourier Analysis, Springer 2008
10	Comment
	recommended: Mathematics: Master (ana)

Module name											
Spectral Theory and Operator Algebras											
Мос	dule no.	Credit Points	Workload	Self-study	Duration	Frequency					
04-1	0-0344	9 CP	270 h	180 h	1 Semester	Irregular					
Lang	guage of	Instruction		Person responsible for the Module							
Geri	man and	English		Prof. Dr. rer. nat. Burkhard Kümmerer							
1	Courses of the Module										

	1										
	Course no. Course name		Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-10-0344-vu	Spectral Theory and Operator Algebras	0	Lecture and Exercise	6						
2	Study Content Banach- and C*-algebras, continuous spectral theory in C*-Algebras, Theory of Gelfand, types of spectra, measure theoretical aspects of spectral theory and representation of operators on Hilbert spaces by multiplication operators, positivity, states, GNS-construction and representations of operator algebras, tensor products, compact operators, examples of C*-algebras.										
3	Learning Outcomes Students are able to compare various approaches to spectral theory, to integrate spectral theory for operators on Hilbert spaces into the operatoralgebraic spectral theory, to explain the basic notions and results in the theory of commutative and non-commutative operator algebras, to apply basic techniques from operator algebras, to construct and compare representations of operator algebras.										
4	-	or Participation Functional analysis									
5	Form of Examin Final Module Ex	amination:	ation. oral / written E	xamination. Sta	ndard)						
	 Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 										
6	Requirements of Passing the Fac	on the Award of Credit Points hprüfung									
7	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)										
8	Usability of the B.Sc Mathemat	Module ik, M.Sc. Mathematik, M.Sc. Mat	hematics								
9	Literature W. Arveson: An	Invitation to C*-Algebras									

	J.B.Conway: A Course in Functional Analysis V. Jones: Von Neumann Algebras. Vorlesungs-Skript, im Internet unter http://math.berkeley.edu/~vfr/math20909.html G. Murphy: C*-Algebras and Operator Theory M. Takesaki: Theory of Operator Algebras 1
10	Comment recommended: Mathematics: Master (alg)

Mo	dule nam	ne								
	Verte	ex Algeb	oras							
Module no. Credit Points Workload						study	Duratio	n	Freque	ncy
04-1	10-0345		5 CP	150 h		105 h	1 Semes	ter	Irregula	ır
	guage of man and		ion			on responsib . Dr. rer. nat.				
1	Course	s of the I	Module							
	Course no. Cours		Course	name		Workload ((CP)	Form Teacł	-	Contact Hours per Week
	04-10-0	345-vu	Vertex A	lgebras		0		Lecture Exercis		3
2 3	introdu Learnin	on and p ction to g Outco	the repro	s of vertex algebras esentation theory,	oossil	oly orbifold th	neory and	l mons	trous mo	oonshine
				r with the definition more they know the		• •		-		
4	-	ements f nended:	or Partic Algebra	ipation						
5		f Examir odule Ex	ation aminatio	on:						
	•	Module	e Examin	ation (Technical Exa	amina	ation, oral / w	vritten Ex	aminat	ion, Sta	ndard)
	when t	here are	only a sr	Examination): Usua nall number of pote oral exam. The deci	ential	participants.	In this ca	ase, the	e exam c	an be

-	
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Kac: Vertex algebras for beginners, AMS
	Frenkel, Ben-Zvi: Vertex algebras and algebraic curves, AMS
10	Comment
	recommended: Mathematics: Master (alg)
	Selected topic in Lie algebras

Mo	dule nan	ne								
	Ellipt	ic curv	es and n	nodular forms						
Module no.Credit PointsWorkload04-10-5 CP1500366/de5 CP150		Workload 150 h	Self-study Duration			. ,		•		
Lan	guage of	Instruc	tion		Pers	on responsib	le for the	e Modu	ule	
Ger	man				Prof	. Dr. rer. nat.	Jan Hend	rik Bru	uinier	
1	Courses of the Module									
	Course no. Course			name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	04-10-0366-vu Elliptic curves and modular fo				0		Lectur Exercis		3
2	Comple series,	modular	-	ic and algebraic the classical conjectures cations.	-	-				

3	Learning Outcomes After attending this course, students will know the elementary theory of elliptic curves and modular forms.
4	Requirements for Participation
	Algebra, Funktionentheorie
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Technical Examination, Standard)
	Module Examination (Study Examination, Study Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
	Bachelor-Modul (und somit auch Ergänzungsbereich im Master), kann aber nicht im Vertiefungsbereich Master eingebracht werden!
9	Literature
	Fred Diamond, Jerry Shurman: A first course in modular forms.
	Anthony W.\ Knapp: Elliptic curves.
	Neal Koblitz: Introduction to elliptic curves and modular forms.
10	Comment

Module nam	ne				by partial differential n Frequency
	erical analysis tions	of optimal cont	rol problems g	overned by p	artial differential
Module no.	Credit Points	Workload	Self-study	Duration	Frequency

04-1	0-0368		5 CP	150	h	105 h	1 Semest	ter	Irregul	ar	
Lang	guage of	Instruct	ion		Pe	Person responsible for the Module					
_	nan and				Prof. Dr. rer. nat. Stefan Ulbrich						
1	Courses	s of the	Module								
	Course no. Course name					Workload (CP)	Form Teacl	-	Contact Hours per Week	
	04-10-0368-vu Numerical analysis of optin control problems governed partial differential equation					0		Lectur Exercis		3	
2	equatio	limensio ons by th	e finite-e	oximation of optir element method; a e finite-element li	a-pric	ori error analys	is and nur				
3	Student - are pr subject	oficient to parti	in the nu al differe	merical analysis a ntial equations. ulties in the discre		-		timiza	tion pro	oblems	
4	recomn	nended:		i pation ar Optimization ar eering course), P[•			•	s (e.g. PDE	
5	Final M Fachpri when tl taken ir commu	Modul ifung (To nere are n the for nicated	caminatic e Examin echnical I only a sr m of an c	ation (Technical E Examination): Usu nall number of po oral exam. The dee ne first two weeks	ally t tenti cision	he exam is tak al participants about the for	en in form In this ca m of the e	n of a v se, the exam is	written e exam o s taken a	test, except can be and	
6	-		on the Av hprüfung	ward of Credit Poi	nts						
7	•	odule Ex Modul Standai		ation (Technical E	xami	nation, oral / v	vritten Exa	aminat	tion, We	eight: 100%,	
-		,									

	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Tröltzsch: Optimale Steuerung partieller Differentialgleichungen S. Brenner, R. Scott: The Mathematical Theory of Finite Element Methods
10	Comment recommended: Mathematics: Master (opt)

Mod	lule nam PDE I		lution E	quations							
Mod	lule no.			Workload		Self-	study	Duratio	n	Freque	ncy
04-1	0-0369		5 CP		150 h		105 h	1 Semes	ter	Irregula	ar -
-	guage of man and		ion				on responsib . Dr. rer. nat.				
1	Courses	s of the l	Module								
	Course	Course no. Course name					Workload ((CP)	Form Teach	•.	Contact Hours per Week
	04-10-03	369-vu	PDE II.D	Evolution Equ	ations	0		Lecture and Exercise		3	
		•					ions due to H maximal reg		ida anc	l/or Lum	ier-
3	Student - under - develo - are ab	stand an op an ad [,] le to ext	d are ab vanced lo end thei		rstandii in this	ng of field	nethods and evolution eq ld		eated i	n the co	urse
4	-		or Partic Functior	ipation nal Analysis							
5			aminatio		ical Ev	min	ation, oral / w	ritton Fr	aminat	ion Sta	undard)
	•	would	ELAIIIII			a111111c	nion, orar / w	A REAL EX	annid	.ioii, 3td	inuaru)

	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Engel, Nagel: One-parameter semigroups for linear evolution equations, Springer, New York, 2000 Pazy: Semigroups of linear operators and applications to partial differential equations, Springer, New York, 1992 Arendt, Betty, Hieber, Neubrander, Birkhäuser 2011
10	Comment recommended: Mathematics: Master (ana) Builds on "Partial Differential Equations I". Upon approval, contents of two PDE II.X-courses may replace "Partial Differential Equations II" and can be combined with the content from "Partial Differential Equations I" as an "Advanced Course in Analysis". Combinations of two or more PDE II.X-courses as additional courses require approval, too.

Мос	Module name										
	Stochastic processes I										
Module no. Credit Points Workload Self-study Duration Frequency								су			
04-1	-10-0372 9 CP 270 ł		270 h		180 h 1 Semester Irregular						
Lang	guage of	Instruct	ion			Pers	on responsib	le for the	Modu	ıle	
Geri	man and	English				Prof. Dr. rer. nat. Volker Martin Betz					
1	1 Courses of the Module										
	Course	no.	Course	name			Workload (CP)	Form	of	Contact

	1	Г			
				Teaching	Hours per Week
	04-10-0372-vu	Stochastic processes I	0	Lecture and Exercise	6
2	 Brownian mot general theory Ito integral 	existence of stochastic processe ion: definition, existence and in y of Gaussian processes erential equations		discrete time	
3	- develop an int	mes ad are able to apply the notions rermediate level of understand rend their knowledge in this fie	ng of the theory of st		
4	recommended:	for Participation Analysis, Linear Algebra, Proba with functional analysis will be			
5	Fachprüfung (To when there are taken in the for	camination: e Examination (Technical Exam echnical Examination): Usually only a small number of potent m of an oral exam. The decisio during the first two weeks of th	the exam is taken in f ial participants. In thi n about the form of t	form of a written s case, the exam he exam is taken	test, except can be and
6	Requirements of Passing the Fac	on the Award of Credit Points hprüfung			
7	Grading Final Module Ex Module Standar	e Examination (Technical Exam	ination, oral / writter	n Examination, W	eight: 100%,
8	Usability of the B.Sc Mathemat	Module ik, M.Sc. Mathematik, M.Sc. M	athematics		
9	Mörters and Pe	heinlichkeitstheorie res: Brownian motion an random functions			

	Karatsas and Shreve: Brownian motion and stochastic calculus
10	Comment recommended: Mathematics: Master (sto)

Мо	dule nan	ne						
	Stock	nastic p	rocesse	s IIA				
Мо	dule no.	Credit F	Points	Workload	Self-study	Duration	Freque	ency
04-2	10-0373		9 CP	270 h	180 h	1 Semester	Irregul	ar
Language of Instruction					Person responsib	le for the Moo	lule	
German and English					Prof. Dr. rer. nat.	Frank Aurzada		
1	Course	s of the	Module					
	Course no. Course			name	Workload ((-	n of hing	Contact Hours per Week
	04-10-0373-vu Stochast			ic processes IIA	0	Lectu Exerc	re and ise	6
	renewa	I proces	ses	ete time, elementar ng theory and risk t		v chains in con	tinuous t	time,
3	Studen - under - develo - are ab	stand ar op an ad ole to ext	nd are ab vanced le cend thei	le to apply the notic evel of understandi r knowledge in this rvised research in th	ng of the theory of field			ourse
4	-		f or Partic Stochast	cipation tic Processes I				
5			aminatio	on: ation (Technical Ex	amination, oral / w	vritten Examina	ation, Sta	andard)

	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Klenke: Wahrscheinlichkeitstheorie
	Sato: Levy processes and infinitely divisible distributions
	Bertoin: Levy processes
	Protter: Stochastic integration and differential equations
10	Comment
	recommended: Mathematics: Master (sto)

Mo	dule nan	ne									
	Appl	ied Geo	metry								
04-:	dule no. 10- 5/de	Credit I	Points 9 CP	Workload	270 h	Self-st	•	Duratio 1 Semes	-	Frequer Irregula	•
	Language of Instruction German and English 1 Courses of the Module						responsib r. rer. nat.			le	
	Course	Course no. Course		name		v	Workload (C		Form Teach		Contact Hours per Week
	04-10-0	04-10-0375-vu Applied Geometry				0			Lecture Exercis		6

2	Study Content Bernstein polynomials, Bézier curves, B-splines, spline curves, tensor product splines, spline surfaces, subdivision algorithms, smoothing of curves and surfaces, curvature estimation on polylines and triangular meshes.
3	Learning Outcomes Students - understand basic mathematical principles of computer-aided geometric modeling of curves and surfaces - are able to assess their significance for theoretical and applied purposes - thoroughly understand the relationship between analytical properties of the involved function spaces and geometric properties of the manifolds they parametrise.
4	Requirements for Participation recommended: Differential Geometry
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Module Examination (Study Examination, Study Examination, Passed / Not Passed) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Hoschek und Lasser, Grundlagen der geometrischen Datenverarbertung, Teubner Prautzsch, Boehm und Paluszny, Bézier and B-Spline Techniques, Springer Peters und Reif, Subdivision surfaces, Springer

	Hoschek und Lasser, Grunglagen der geometrischen Datenverarbertung, Teubner Prautzsch, Boehm und Paluszny, Bézier and B-Spline Techniques, Springer Peters und Reif, Subdivision surfaces, Springer
10	Comment recommended: Mathematics: Master (geo)

	Appr	oximat	ion theo	orv						
Module no. 04-10- 0376/de		Credit I		oints Workload		Self-study 180 h		n ter	Frequency Irregular	
	iguage of rman and		tion			on responsib Dr. rer. nat.			ule	
1	Course	s of the	Module							
	Course	no.	Course	name		Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-10-0376-vu		Approximation theory			0		Lecture and Exercise		6
	Whitno			ropic Sobolev space		ance spline-o	ontroll p	olygon	, Schoe	-
	theorer	y theore ns, unifo	em, natu orm stab	ropic Sobolev space ral and canonical sp ility, orthogonality ement method	line in	ance spline-o iterpolant, qu	controll p uasi inter	olygon polatic	n, Schoe on, Jacks	nberg-
3	theorer approxi Learnin Studen - under splines - recogn - develo	y theore ms, unifo imation, og Outco ts stand ke nise the op an un	em, natur orm stab finite ele o mes ey aspect crucial ro derstanc	ral and canonical sp ility, orthogonality	line in relatic multiv als for	ance spline-o iterpolant, qu ons, smoothi variate appro stability and f approximat	controll p uasi inter ng spline ximation	olygon polatic s, geor s with mation	n, Schoe on, Jacks netric polynor proper	nberg- son type mials and ties
3	theorer approxi Learnin Studen - under splines - recogi - develo - can ap	y theore ms, unifo imation, g Outco ts stand ke nise the op an un oply suita	em, natur orm stab finite ele o mes ey aspect crucial ro derstanc able met	ral and canonical sp ility, orthogonality ement method s of linear uni- and ole of dual functiona ding of various meth hods of approximat	line in relatic multiv als for	ance spline-o iterpolant, qu ons, smoothi variate appro stability and f approximat	controll p uasi inter ng spline ximation	olygon polatic s, geor s with mation	n, Schoe on, Jacks netric polynor proper	nberg- son type mials and ties

Module Examination (Technical Examination, oral / written Examination, Standard)
Module Examination (Study Examination, Study Examination, Passed / Not Passed)
Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Study Examination, Weight: 0%, Passed / Not Passed)
Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
Literature de Boor, A Practical Guide to Splines, Springer Schumaker, Spline functions basic theory, Cambridge University Press Höllig, Finite element methods with B-splines, SIAM
Comment recommended: Mathematics: Master (geo)
-

Mo	Module name											
	Representation Theory											
04-2	Module no. 04-10- 0378/deCredit PointsWorkloadSelf-studyDurationFrequency5 CP5 CP150 h105 h1 SemesterEvery 2. semester											
	guage of	Instruct	ion				on responsik Dr. rer. nat.					
1	Courses of the Module											
	Course	no.	Course	name			Workload (CP) Form		Form	of	Contact	

				Teaching	Hours per Week
	04-10-0378-vu	Representation Theory	0	Lecture and Exercise	3
2	reducibility, Ma product, wedge of the symmetr	sentations of finite groups, aschke's theorem, Schur's le product, character theory ric group, arbitrary ground f restriction and induction, n	emma, tensor proc , group algebra, re ield, division algel	duct, symmetric epresentations bras,	
3		re familiar with the basic re x numbers. They are able to	•		•
4	•	for Participation Algebra, Einführung in die	Algebra		
5				written Examination, St	andard)
-					
7	Grading Final Module E Modul Standa	e Examination (Technical E	xamination, oral /	written Examination, W	eight: 100%,
8		e Module ertiefungsbereich gänzungsbereich			
9		resentation theory, ar Representations of Finite	e Groups.		
10	Comment				

			nn Algeb		Γ		1									
Module no. Credit Points Workload							Duratio		Frequency							
	10-0379		9 CP	270 h			1 Semes		Irregul	ar						
	guage of		ion		Person re											
	man and				Prof. Dr.	er. nat.	Burkhard	l Kûmn	nerer							
1	Courses	s of the	Module													
	Course	no.	Course name		Wo	kload (CP)	Form of Teaching		Contact Hours per Week						
	04-10-0	379-vu	von Neu	0	0			e and se	6							
	of von I - Norma algebra - Standa index th	Neuman al repres s ard repre neory of , knots,	n algebra sentation esentation V. Jones	ions, classification as, and examples of is of von Neumann on and for finite factors ariants, Jones	different	types.										
	polynoi	niai.							Learning Outcomes Students are able to construct von Neumann algebras, to distinguish between various different topologies on von Neumann algebras, to construct normal states with their corresponding cyclic representations, to compare projections, to classify von Neumann algebras, to construct towers of von Neumann algebras, to compute the index of a subfactor, to distinguish between different knots, and to compute knot polynomials.							
3	polynoi Learnin Studen topolog represe of von l	g Outco ts are ab gies on v entations Neuman	le to co on Neum s, to com n algebra	nann algebras, to co pare projections, to as, to compute the i	nstruct no classify v	rmal sta on Neur	ates with nann alge	their c bras, t	orrespo o const	nding cycli ruct tower						
3	polynoi Learnin Student topolog represe of von l knots, a	g Outco ts are ab ties on v entations Neuman and to co ements f	le to col on Neum s, to com n algebra ompute k	nann algebras, to co pare projections, to as, to compute the i knot polynomials.	onstruct no o classify vo index of a	rmal sta on Neur subfacto	ates with nann alge or, to dist	their co ebras, t inguish	orrespo o const	nding cycli ruct tower						

	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature M. Takesaki: Theory of Operator Algebras I. R.V. Kadison, J.R. Ringrose: Fundamentals of the Theory of Operator Algebras I,II. G. Pedersen: C*-Algebras and their Automorphism Groups. V. Jones, V.S. Sunder: Introduction to Subfactors. V. Jones: Subfactors and Knots.
10	Comment recommended: Mathematics: Master (alg)

Mo	dule nan	ne									
	Nonl	inear Fu	unctiona	al Analysis							
04-1	dule no. 10- 1/en	Credit I	Points 9 CP	Workload 270		lf-study		Duratio 1 Semes	-	Freque r Every 2.	icy semester
	Language of Instruction English 1 Courses of the Module					Person responsible for the Module Prof. Dr. rer. nat. Reinhard Farwig					
	Course	Course no. Course name			Wor	kload ((CP)	Form Teach	•	Contact Hours per Week	
	04-10-0381-vu Nonlinear Functional Analysis		is	0			Lecture Exercis		6		

2	Study Content Fixed point theorems; calculus in Banach spaces; degree theory on \$\mathbb{R}^n\$ and in Banach spaces; bifurcation theory; monotone operators
3	Learning Outcomes transfer of classical results from Analysis to Banach space – valued functions; comprehension of different methods from Functional Analysis for the solution of nonlinear problems; Analysis of bifurcation and stability problems and their applications
4	Requirements for Participation Linear functional analysis
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M.ScMath: Vertiefungsbereich M.ScMath: Ergänzungsbereich
9	Literature A. Ambrosetti, G. Prodi: A primer of nonlinear analysis. Cambridge University Press 1993 K. Deimling: Nonlinear functional analysis. Springer 1974 M. Ruzicka: Nichtlineare Funktionalanalysis. Springer 2004
10	Comment

Module nam	ne				
Lie G	roups				
Module no.	Credit Points	Workload	Self-study	Duration	Frequency
04-10- 0382/de	5 CP	150	-	1 Semester	Every 2. semester

	guage of Instruct	tion		on responsible for				
	rman		Prof	. Dr. rer. nat. Nils S	cheithauer			
1	Courses of the Course no.	Module Course name		Workload (CP)	Form of Teaching	Contact Hours per		
	04-10-0382-vu	Lie groups		0	Lecture and Exercise	Week 3		
2	Study Content Differential Calculus on submanifolds, Lie groups as ``differentiable group'', matrix groups, Lie algebra of a Lie group, Lie functor, Lie group-exponential function							
3	Learning Outcomes Nach dem Besuch des Moduls \begin{itemize} \item sind die Studierenden mit den grundlegenden Definitionen von Lie-Gruppe, Lie-Algebra, Lie-Gruppen-Morphismus, Lie-Funktor, adjungierter Darstellung und Lie-Gruppen-Exponentialfunktion vertraut \item haben die Studierenden einige wichtige konkrete Beispiele von reellen und komplexen Matrizengruppen kennengelernt und können mit ihnen hantieren \item haben die Studierenden einen ersten Einblick in die Theorie (endlichdimensionaler reeller) Lie-Gruppen erhalten und verstanden, wie man solche mit Hilfe von Lie-Algebren untersuchen kann. \end{itemize}							
4	Analysis, Linear	for Participation e Algebra, Einführung in die se in Topologie sind hilfreich			uppentheorie).\			
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) 							
6	Requirements	on the Award of Credit Poir	nts					
7	Grading Final Module Ex Modul Standa	e Examination (Technical Ex	amina	ation, oral / writter	n Examination, W	eight: 100%,		
8		e Module ertiefungsbereich gänzungsbereich						

9	Literature \begin{itemize} \item Vorlesungsskript, \item J. Hilgert#47;K.H. Neeb: Lie-Gruppen und Lie-Algebren, Vieweg (1991) \end{itemize}
10	Comment Vertiefungsniveau

Мо	dule nam Com		nal Fluic	l Dynamics						
Мо	dule no.			Workload	Self	study	Duratio	n	Freque	ency
04-	10-0384		9 CP	270 h		180 h	1 Semes	ster	Irregul	ar
	guage of man and		ion			on responsib . Dr. rer. nat.				
1	Courses of the Course no.		Module Course	name		Workload (of ning	Contact Hours per Week
	04-10-0384-vu Computationa			ational Fluid Dynamic	al Fluid Dynamics 0		C		e and e	6
	Modelling: Reynolds transport theorem; conservation of mass and momentum; Navier-Stokes and Euler equations; boundary conditions; siomplified models; Analysis: weak formulation; existence and uniqueness results for Stokes and Navier-Stokes; Numerics: The finite element method for coercive and non-coercive problems; convergence analysis; convection-diffusion problems; stable discretization for the Stokes problem; numerica tretament of the Navier-Stokes equations;								Stokes; ergence	
3	Learnin	g Outco	mes							
	The students understand the basic equations of fluid dynamics, their origin, and elementary properties. They know about the basics results on solvability of these models and about thei numerical solution by finite element methods. The students are able to explain, analyse, and implement the finite element methods.							out their		
4	recomn methoc useful c	nended: ls :ourses:	Function	ipation I: basic knowledge al Analysis, Partial Intial Equations	•					

5	Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	 Literature D. Braess: Finite Elemente, Springer. D. C. Brenner, L. R. Scott: The mathematical theory of finite element methods, Springer. V. Girault, PA. Raviart: Finite Element Approximation of the Navier-Stokes Equations, Springer. C. Johnson: Numerical solution of partial differential equations by the finite element method, Dover. R. Temam, Navier-Stokes Equations, North-Holland Publishing.
10	Comment recommended: Mathematics: Master (num)

Мос	dule nan	ne									
	Monadic Second Order Logic										
Module no. 04-10- 0385/deCredit Points 5 CPWorkload150 h				Self-	•	Duration	-	Frequen Every 2. :	cy semester		
Lan g Geri	guage of man	Instruct	ion				o n responsil Dr. rer. nat.			le	
1	Courses of the Module										
	Course	no.	Course	name			Workload (CP)	Form	of	Contact

-							
				Teaching	Hours per Week		
	04-10-0385-vu	Monadic Second-Order Logic	0	Lecture and Exercise	3		
2		d-order logic; composition and automata; monadic theories o			of linear		
3	in der Lage die	m es können Sachverhalte in monac üblichen Automaten-Konstruk varkeitsresultate zu beweisen.	-				
4	Vertrautheit mi	for Participation t Grundbegriffen der Logik, wi Grundlagen''' vermittelt wird.	e sie z. B. in de	er "`Einführung in die Lo	ogik"' oder		
5				written Examination,	Standard)		
7	Grading Final Module Ex Module Standar	e Examination (Technical Exam	nination, oral /	written Examination, V	Neight: 100%,		
8	Usability of the M.ScMath: Ve	• Module •rtiefungsbereich Logik; Ergänz	ungsbereich				
9	Literature D. Perrin, JE. Pin, \textit{Infinite Words Automata, Semigroups, Logic and Games,} Elsevier, 2004.						
	University Press	nomas, T. Wilke, Autom		-			
10	Comment Vertiefungsnive	eau					

	Elem	entary	Numbei	Theory (for Teac	hing Degrees)	T		1			
-	dule no.	Credit F	oints	Workload	Self-study	Duration	ı	Frequer	псу		
	10- 9/de		5 CP	150 h	105 h	1 Semes	ter	Every 4.	semester		
Language of Instruction					Person responsi						
	man				Prof. Dr. rer. nat	Nils Sche	ithaue	r			
1		s of the l					1_		<u> </u>		
	Course no. Course name			name	Workload (CP)	Form Teach		Contact Hours per Week		
	04-10-0	389-vu	Element (Lehram	ary Number Theory t)	0		Lecture Exercis		3		
3	Learnin	ig Outco	mes	egers, Dirichlet's pri							
4	Require	ements f Algebra	or Partic								
	Form o	Final Module Examination:									
5		-	aminatio	on:							
5		odule Ex Module	e Examin	on: ation (Technical Exa ation (Study Examin							
5	Final M Fachpri when the taken in commu	odule Ex Module Module üfung (Te here are n the for inicated	e Examin e Examin echnical only a si m of an o	ation (Technical Exa ation (Study Examin Examination): Usua mall number of pote oral exam. The decim ne first two weeks o	nation, Special Fo Ily the exam is tak ential participants sion about the for	rm, Passe en in forn . In this ca m of the e	d / No n of a v ase, the exam is	t Passed) written to e exam ca s taken a) est, excep an be nd		

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature Schmidt: Einführung in die algebraische Zahlentheorie, Springer Bundschuh: Einführung in die Zahlentheorie, Springer Müller-Stach: Elementare und algebraische Zahlentheorie: Ein moderner Zugang zu klassischen Themen, Vieweg Ireland, Rosen: A classical introduction to modern number theory, Springer Apostol: Introduction to analytic number theory, Springer
10	Comment

	Mixe	d-Integ	ger Nonl	inear Optimizatio	n					
Мо	dule no.	Credit	Points	Workload	Self-	Self-study Duration			Frequency	
04-:	-10-0390 5 CP 150 H			150 h		105 h	1 Semest	ter	Irregula	ır
Lan	guage of	Instruc	tion		Pers	on responsib	le for the	Modu	ıle	
Ger	man and	English			Prof.	Dr. rer. nat.	Marc Pfet	tsch		
1	Courses of the Module									
	Course no. Course		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	390-vu	Mixed-Ir Optimiza	nteger Nonlinear ation		0		Lecture Exercis		3
2	branch	integer		er approximation, s ion problems, solut		-	•	•		

3	Learning Outcomes Students of this course will understand relevant techniques for the solution of nonlinear optimization problems with integrality constraints.
4	Requirements for Participation recommended: Nonlinear Optimization or Discrete Optimization
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature R. Horst, H. Tuy: Global Optimization: Deterministic Approaches, Springer, 1996. M. Locatelli, F. Schoen: Global Optimization: Theory, Algorithms, and Applications, MOS-Siam Series on Optimization, 2013
10	Comment recommended: Mathematics: Master (opt)

Module name								
Num	erical Methods	for Partial Diff	fere	ential Equations				
Module no.	Credit Points	Workload		Self-study	Duration	Frequency		
04-10-0391	9 CP	270	0 h	180 h	1 Semester	Every 2. semester		
Language of	Language of Instruction Person responsible for the Module							

Gerr	man and English		Prof. Dr. rer. nat. Jens Lang, Prof. Dr. rer. nat. Jan Giesselmann						
1	Courses of the Course no.	Module Course name		Workload (CP)	Form of Teaching	Contact Hours per Week			
	04-10-0391-vu	Numerical Methods for Partia Differential Equations	I	0	Lecture and Exercise	6			
2	analysis of ellip analysis; Parab	artial differential equations i tic variational problems; Gal olic problems: weak formula method and the method of	lerkin tion,	approximation, fir energy estimates,	nite element met	nods, error			
3	element metho	re able to solve elliptic and p ods. They understand the bas plement them. Students can	sic co	nstruction of these	e methods and are	e able to			
4	recommended:	for Participation Introduction to Numerical A milar knowledge as taught in				Differential			
5	Fachprüfung (T when there are taken in the for	xamination: e Examination (Technical Exa echnical Examination): Usua e only a small number of pote rm of an oral exam. The deci during the first two weeks o	lly th ential sion a	e exam is taken in participants. In th about the form of t	form of a written is case, the exam he exam is taken	test, except can be and			
6	Requirements on the Award of Credit Points Passing the Fachprüfung								
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100% Standard) 								
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics								

9	Literature
	Braess: Finite Elemente: Theorie, schnelle Löser und Anwendungen in der Elastizitätstheorie, Springer, 2013. Larsson, Thomee: Partial Differential Equations with Numerical Methods, Springer, 2003. Großmann, Roos: Numerische Behandlung Partieller Differentialgleichungen, Teubner, 2005.
10	Comment recommended: Mathematics: Master (num)

Mo	dule nan	ne								
	Num	erical N	/lethods	for Ordinary Diff	erent	tial Equation	ns			
04-2	dule no. 10- 3/de	Credit I	Points 9 CP	Workload 270 h		study 180 h	Duration 1 Semester		Frequency Every 2. semeste	
	guage of man	Instruct	ion		Prof	on responsib . Dr. rer. nat. selmann				nat. Jan
1	Course	s of the	Module							
	Course no. Course			name		Workload ((CP)	Form Teach	•••	Contact Hours per Week
	04-00-0	138-vu	Numeric Equation	s of Ordinary Differer	ntial	0		Lecture and Exercise		6
2	stability bounda convers	alue pro /; ary-value gence;	e problen	ne-step methods, n ns: Shooting metho tions: Finite differer	ds, fir	nite differenc	e methoc	ls, stab	ility and	notions of
3	Learning Outcomes Students know some basic numerical solution concepts for ordinary differential equations and for simple partial differential equations. They are able to analyze, compare, and apply them.									
4	Requirements for Participation recommended: Analysis, Linear Algebra, Ordinary Differential Equations, Introduction to Numerical Analysis or similar knowledge as taught in an engineering programme.									
5	Form of Examination Final Module Examination:									

Module Examination (Study Examination, Special Form, Passed / Not Passed)
 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
Literature Deuflhard, Bornemann: Numerische Mathematik 2 Stoer, Bulirsch: Numerische Mathematik 2
Comment recommended: Mathematics: Bachelor year 3 (num)

Mo	dule nam	ne									
	Discontinuous Galerkin Methods										
Mo	dule no.	Credit Points	Workload		Self-s	tudy	Duration		Frequen	uency	
04-2	10-0395	6 CP	1	180 h		120 h 1 Semester Irregu		Irregular	gular		
Lan	guage of	Instruction			Perso	n responsib	le for the	Modu	ıle		
Ger	man and	English			Prof.	Dr. rer. nat.	Jan Giesse	elman	n		
1	Course	s of the Module									
	Course	no. Course	e name		,	Workload (Form Teach	••	Contact Hours	

					per Week
	04-10-0395-vu	Discontinuous Galerkin Metho	ds 0	Lecture and Exercise	4
2		ntinuous Galerkin methods; iting; INterior Penalty (IP), lo n Matlab)			
3	partial different	mes arn about the abstract form tial equations of first and sec and to apply them to convec	ond order. The	y are able to explain and	analyse
4	recommended: an engineering	for Participation required: Introduction to Nu programme; Numerical Analysis of Partial	-	-	-
5	Fachprüfung (To when there are taken in the for	camination: e Examination (Technical Exa echnical Examination): Usuall only a small number of pote m of an oral exam. The decis during the first two weeks of	ly the exam is t ntial participan ion about the f	aken in form of a written ts. In this case, the exam orm of the exam is taken	test, except can be and
6	Requirements of Passing the Fac	on the Award of Credit Point hprüfung	S		
7	Grading Final Module Ex Modul Standar	e Examination (Technical Exa	mination, oral ,	/ written Examination, W	eight: 100%,
8	Usability of the B.Sc Mathemat	Module ik, M.Sc. Mathematik, M.Sc. I	Mathematics		
9	Springer)	A. Ern: Mathematical Aspects			

10	Comment
	recommended: Mathematics: Master (num)

Мо	dule nan	ne										
	Ellipt	ic Curv	es			r						
04-	odule no. 10- 96/de 5 CP Workload 150		Workload 150 h	Self-study 105 h	Duration 1 Semeste		Freque Every 2	ncy . semester				
	guage of man and		tion		Person responsik Prof. Dr. rer. nat.							
1	Course	Courses of the Module										
	Course	no.	Course	name	Workload (-	Form c Teachi	-	Contact Hours per Week			
	04-10-0	396-vu	Elliptic C	urves	0		ecture xercise		3			
3	Theore Learnin After at	m, the L g Outco	utz-Nage mes this cou	the group structure II Theorem rse, students will be								
4				projective curves.								
4	Algebra	l,	f or Partic se in alge	braischer Zahlenth	eorie sind hilfreich							
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) 											
6	Require	ements	on the A	ward of Credit Poin	ts							
7	Grading Final M	-	kaminatio	on:								

8	Usability of the Module
	M.ScMath: Vertiefungsbereich
	M.ScMath: Ergänzungsbereich
9	Literature
	Elliptic curves, Anthony W. Knapp\
	The arithmetic of elliptic curves, Joseph H. Silverman
10	Comment
	Vertiefungsniveau

Mo	dule nam		aaru Dro	ioct						
04-2	Interdisciplinary Pro Module no. 04-10- 0398/de Credit Points 2 CP		Workload 60 h		study 45 h	Duratio 1 Semes		Freque Irregul	-	
	guage of man	Instruct	ion			on responsib . Dr. rer. nat.				
1	Courses of the Module Course no. Course name			name		Workload (CP)	Teaching		Contact Hours per Week
	04-10-0	398-pr	Interdisc	iplinary Project		0			Project 1	
2	interdis A comp method Specific	of stude sciplinary plex and ds. The st	v project open-en tudents ned men	fferent study progr with real-life applie ded problem is trea need to find and de nbers of the particip	cation ited w fend t	s. vith mathema their own app	itical and proaches	l interd to the	isciplina problei	ary m.
3	Learning Outcomes Students know the value of mathematical reasoning. They can work in interdisciplinary groups and make valuable contributions.									
4	Requirements for Participation none									
5	Form of Examination Final Module Examination:									

	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Studienleistung: Giving an oral presentation about the results of the project.
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik
9	Literature
10	Comment
	recommended: Mathematics: Bachelor year 2

Мо	dule nam		uranco	Mathematics						
04-	dule no.	Credit I		Workload 150 h		Self-study Duration 105 h 1 Semes				-
Language of Instruction German						on responsib . Dr. rer. nat.			le	
1	Courses of the Module Course no. Course name					Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	501-vu	Non-Life	Insurance Mathemat	tics	0		Lectur Exercis		3
2	 Study Content collective and individual model of insura computation and approximation of the e computation of expectation and other p ruin problem and premium computation estimation methods for distributions selection effects 				stribu					

	- reservation - risk distribution - re-insurance
3	Learning Outcomes Students should get a first impression on the branch of insurance mathematics. The goal is to prepare for later actuarial studies (e.g. when working for an insurance company). The main focus is on classical risk models. Further topics like tarifs, reservation, and re-insurance are touched.
4	Requirements for Participation Introduction to Stochastics
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, oral / written Examination, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Study Examination, oral / written Examination, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc.Math, B.Sc.WiMa: Wahlpflichtbereich Für M.Sc.Math, M.Sc.WiMa: Ergänzungsbereich
9	Literature Klaus D. Schmidt, Versicherungsmathematik. Thomas Mack, Schadenversicherungsmathematik.
10	Comment Verantwortlich: Herr Aurzada (sto)

	Harn	nonic Aı	nalysis c	on Abelian Gro	ups					
Mc	dule no.			Workload		f-study	Duration		Frequency	
04-	10-0502		5 CP	15	0 h	105 h	1 Semes	ter	Irregula	ar
Lar	nguage of	Instruct	ion		Ре	rson responsib	le for the	e Modu	ule	
Ge	rman and	English			Pro	of. Dr. rer. nat.	Mads Ky	ed		
1	Courses of the Module					I				1
	Course	no.	Course name			Workload ((CP)) Form of Teaching		Contact Hours per Week
	04-10-0502-vu Harmonic Analysis on Abelia Groups								cture and 3 ercise	
3		IEIS UN L	CA group	JSJ.						
	Studen course - develo abelian - are ab	op an ad groups ble to ext	rstand ar vanced l	nd are able to ap evel of understa r knowledge in t	nding c	of abstract harr	nonic ana	alysis o	n locally	/ compact
	Studen course - develo abelian - are ab this fiel	ts under op an ad groups ole to ext d.	rstand ar vanced le cend thei	evel of understa r knowledge in t	nding c	of abstract harr	nonic ana	alysis o	n locally	/ compact
	Studen course - develo abelian - are ab this fiel Require recomr	ts under op an ad groups ole to ext d. ements f nended:	rstand ar vanced le cend thei	evel of understa r knowledge in t cipation ion Theory and b	nding c	of abstract harr d and are able	nonic ana perform	alysis o superv	n locally ised res	v compact earch in
4	Studen course - develo abelian - are ab this fiel Require recomm Analysi	ts under op an ad groups ole to ext d. ements f nended: s or Harr f Examir	rstand ar vanced le cend thei f or Partio Integrat monic Ar	evel of understa r knowledge in t cipation ion Theory and b nalysis	nding c	of abstract harr d and are able	nonic ana perform	alysis o superv	n locally ised res	v compact earch in
4	Studen course - develo abelian - are ab this fiel Require recomm Analysi	ts under op an ad groups ole to ext d. ements f mended: s or Harr f Examir	rstand ar vanced le cend thei for Partic Integrat monic Ar nation kaminatic	evel of understa r knowledge in t cipation ion Theory and b nalysis	nding c	of abstract harr d and are able miliarity with F	nonic ana perform	alysis o superv nalysis	n locally ised res as cover	compact earch in red in Rea

	communicated during the first two weeks of the lecture based on the prospective number of
	communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	W. Rudin: Fourier Analysis on Groups
10	Comment
	recommended: Mathematics: Master (ana)

Мо	dule nam	ne								
	Stock	nastic Fi	inite Ele	ments						
Мо	dule no.	Credit F	Points	Workload	Self-study Duration		n Frequer		ncy	
04-1	04-10-0504 6 CP 180 h				120 h	1 Semest	ter Irregular		r	
Language of Instruction				Pers	on responsib	le for the	Modu	ule		
German and English					Prof	Dr. rer. nat.	Jens Lang	5		
1	Courses of the Module									
	Course no.		Course name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0504-vu Stochas		Stochast	tic Finite Elements		0		Lecture and Exercise		4
2	Study Content Monte Carlo finite elements, multi level Monte Carlo finite elements, Karhunen Loeve expansio of random fields, stochastic Galerkin methods: formulation, implementation, solution and error estimation, stochastic collocation						•			
3		g Outco ts can fo		elliptic boundary va	ilue p	roblems with	random	data a	nd explai	n their

origin in applications like uncertainty quantification. They know the basic numerical solution strategies based on finite element approximations in space. Students are able to formulate, analyze, and compare different numerical methods and to implement and apply them .
Requirements for Participation
recommended: Introduction to Numerical Analysis, Introduction to Stochastics ideally: Numerical Analysis of Partial Differential Equations
Form of Examination
Final Module Examination:
• Module Examination (Technical Examination, oral / written Examination, Standard)
Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
when there are only a small number of potential participants. In this case, the exam can be
taken in the form of an oral exam. The decision about the form of the exam is taken and
communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
Requirements on the Award of Credit Points
Passing the Fachprüfung
Grading
Final Module Examination:
 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
Usability of the Module
B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics Literature G. J. Lord, C. E. Powell, and T. Shardlow. An Introduction to Computational Stochastic PDEs.
 B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics Literature G. J. Lord, C. E. Powell, and T. Shardlow. An Introduction to Computational Stochastic PDEs. Cambridge University Press, 2014.
 B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics Literature G. J. Lord, C. E. Powell, and T. Shardlow. An Introduction to Computational Stochastic PDEs. Cambridge University Press, 2014. R. C. Smith. Uncertainty Quantification: Theory, Implementation, and Applications. SIAM Computational Science and Engineering, 2014.
 B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics Literature G. J. Lord, C. E. Powell, and T. Shardlow. An Introduction to Computational Stochastic PDEs. Cambridge University Press, 2014. R. C. Smith. Uncertainty Quantification: Theory, Implementation, and Applications. SIAM
 B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics Literature G. J. Lord, C. E. Powell, and T. Shardlow. An Introduction to Computational Stochastic PDEs. Cambridge University Press, 2014. R. C. Smith. Uncertainty Quantification: Theory, Implementation, and Applications. SIAM Computational Science and Engineering, 2014. D. Xiu. Numerical Methods for Stochastic Computations: A Spectral Method Approach.

Module name

Arakelov Geometry

-	dule no.	Credit F		Workload			study	Duration	• •		•
	10-0506		5 CP		150 h			1 Semes		Irregu	ar
	guage of		ion				on responsib				
	man and	0				Prof	. Dr. rer. nat.	Jan Hend	rik Br	umer	
1	Courses of the Module								1		
	Course no. Course			name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	506-vu	Arakelo	v Geometry			0		Lectur Exerci		3
2	Study C	ontent						1			
3	divisors	sets, projective varieties, plane projective curves, Bézout's theorem. Arithmetic surfaces, divisors, classical (finite) intersection number; Arakelov divisors, Greens' function, arithmetic intersection number; diophantine applications.									
4	 - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of Arakelov Geometry - are able to extend their knowledge in this field - are able perform supervised research in this field Requirements for Participation 							ourse			
5		recommended: Algebra Form of Examination									
	Final M	Final Module Examination:									
	•	Module Examination (Technical Examination, oral / written Examination, Standard)									
	when the the taken in taken in the taken in	nere are In the for	only a s m of an during t	mall number oral exam. T he first two	r of pote he deci	ential sion a	e exam is tak participants. bout the for lecture, base	In this ca n of the e	ise, th exam i	e exam is taken	can be and
	Requirements on the Award of Credit Points Passing the Fachprüfung										
6	-					its					

8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature William Fulton: Algebraic Curves. An introduction to algebraic geometry. Robin Hartshorne: Algebraic Geometry Serge Lang: Introduction to Arakelov theory.
10	Comment recommended: Mathematics: Master (alg) Selected topic in arithmetic geometry

Mo	dule nan	ne									
	Diffe	rential	Geomet	ry	- [1				
04-1	Module no. 04-10- 0507/de		Points 9 CP			- study 180 h	study Duration 180 h 1 Semes				
	Language of Instruction German					Person responsible for the Module Prof. Dr. rer. nat. Elena Mäder-Baumdicker					
1	Course	s of the	Module								
	Courses of the Module Course no. Course name 04-10-0507-vu Differential Geometry		Course	-		Workload (CP)	Form of Teaching		Contact Hours per Week	
				0		Lecture and 6 Exercise		6			
2	operato	gth and o pr; princi	pal curva	e; selected global atures, Gaussian a port, Gauss-Bonn	and me	an curvature.	Compati	bility e	quation	• •	
3	Learning Outcomes After having attended this module the students have developed an intuition for curvature of curves and surfaces. They know how to describe surfaces in terms of differential geometry and they understand the difference between intrinsic and extrinsic geometric quantities.										
4	-		or Partio Analysis	ipation , Ordinary Differe	ential Ed	quations, Line	ar Algebr	а			
5		f Examir odule Ex	nation caminatio	on:							

	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; Passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik
9	Literature Bär: Elementare Differentialgeometrie Montiel, Ros: Curves and surfaces Hoschek, Lasser: Grundlagen der Geometrischen Datenverarbeitung
10	Comment recommended: Mathematics: Bachelor year 3 (geo), Teaching Degrees
	1

Modul	Module name									
	Differential Geometry									
Modul 04-10- 0507/e		Credit Points 9 CP	Workload	270 h	Self-study 18		Duration 1 Semester	Frequency Every 2. semester		
-	Language of Instruction English				Person responsible for the Module Prof. Dr. rer. nat. Elena Mäder-Baumdicker					
1 Co	ourse	s of the Module		•						

	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-10-0507-vu	Differential Geometry	0	Lecture and Exercise	6						
2	shape operator	gth and curvature; selected glob ; principal curvatures, Gaussian llel transport, Gauss-Bonnet Th	and mean curvature.	Compatibility eq	-						
3	After having att curves and surf	earning Outcomes After having attended this module the students have developed an intuition for curvature of curves and surfaces. They know how to describe surfaces in terms of differential geometry and hey understand the difference between intrinsic and extrinsic geometric quantities.									
4	•	for Participation Analysis, Ordinary Differetial Ec	quations, Linear Algeb	ra							
5	 Module min, Sta Fachprüfung (Te when there are taken in the for 	kamination: e Examination (Study Examinati e Examination (Technical Exami andard) echnical Examination): Usually t only a small number of potenti m of an oral exam. The decisior during the first two weeks of th	nation, oral / written I he exam is taken in fo al participants. In this a about the form of the	Examination, Du rm of a written case, the exam e exam is taken	ration 90 test, except can be and						
6	Passing the Fac	on the Award of Credit Points hprüfung; dienleistung is a prerequisite fo	r taking the Fachprüfu	ng							
7	Passed)	e Examination (Study Examinati) e Examination (Technical Exami		-							
8	Usability of the B.Sc. Mathemat	: Module tik, M.Sc Mathematik, M.Sc. Ma	thematics, LaG Mathe	ematik							

9	Literature Bär: Elementare Differentialgeometrie Montiel, Ros: Curves and surfaces Hoschek, Lasser: Grundlagen der Geometrischen Datenverarbeitung
10	Comment recommended: Mathematics: Bachelor year 3 (geo), Teaching Degrees

	Nons	mooth	Analysi	S							
04-	dule no. 10-)8/de	Credit I	Points 5 CP	Workload 150 h	Self-	study Duration 105 h 1 Semes		•		Jency 2. semester	
	iguage of rman	Instruct	tion			on responsib Dr. rer. nat.					
1	Course	s of the	Module								
	Course	Courses of the Module Course no. Course name				Workload ((CP)	Form Teach	-	Contact Hours per Week	
	04-10-0508-vu Nonsmoo			oth Analysis		0		Lecture and Exercise		3	
	subdiff			•		properties of ules, optimal					
	Non sm	erential, looth an	epsilon : alysis: se	subdifferential, calc everal subdifferentia everal subdifferentia	ulus r als (Cla	ules, optimal arke, Mordul	lity condi khovich,	tions, e .), sem	example	S	
3	Non sm normal	erential, looth an	epsilon : alysis: se coderivat	subdifferential, calc	ulus r als (Cla	ules, optimal arke, Mordul	lity condi khovich,	tions, e .), sem	example	S	
3	Non sm normal	erential, looth an cones, c	epsilon : alysis: se coderivat	subdifferential, calc everal subdifferentia ives, calculus rules,	ulus r als (Cla	ules, optimal arke, Mordul	lity condi khovich,	tions, e .), sem	example	S	
3	Non sm normal Learnin Nach Br - kenne	erential, nooth an cones, c g Outco esuch di n die Stu	epsilon s alysis: se coderivat mes eses Mon udierend	subdifferential, calc everal subdifferentia ives, calculus rules,	ulus r Ils (Cla optin	ules, optimal arke, Mordul nality conditi	ity condi khovich, ons, exar	tions, e .), sem nples	example iismootl	nness,	
3	Non sm normal Learnin Nach Ba - kenne nichtdit	erential, nooth an cones, c g Outco esuch di n die Sti ferenzie	epsilon s alysis: se coderivat mes eses Mod udierend erbare Fu	subdifferential, calc everal subdifferentia cives, calculus rules, duls en verallgemeinerte	ulus r als (Cla optin	ules, optimal arke, Mordul nality conditi	lity condi khovich, ons, exar	tions, e .), sem nples	example iismootl	nness,	

	Gleichungen und Optimierungsprobleme
4	Requirements for Participation Analysis, Lineare Algebra
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Module Examination (Study Examination, oral / written Examination, Passed / Not Passed)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) Module Examination (Study Examination, oral / written Examination, Weight: 0%, Passed / Not Passed)
8	Usability of the Module B.Sc.Math:Wahlpflichtbereich, M.Sc.Math:Ergänzungsbereich
9	Literature W. Schirotzek: Nonsmooth Analysis F. Clarke: Optimization and Nonsmooth Analysis T. Rockafellar: Convex Analysis T. Rockafellar and R.Wets: Variational Analysis B. Mordukhovich: Variational Analysis and Generalized Differentiation
10	Comment

Module name

Automorphic Forms

Мо	dule no.	Credit F	Points	Workload		Self-	study	Duration	1	Freque	ncy		
04-1	LO-0509		9 CP		270 h		180 h	1 Semest	ter	Irregula	ar		
Lang	guage of	Instruct	ion			Pers	on responsib	le for the	Mod	ule			
Geri	man and	English				Prof	. Dr. rer. nat.	Jan Hend	rik Brı	uinier			
1	Course	s of the I	Module										
	Course	ourse no. Course name Workload (CP)				ie Workload		Form of Teaching		Contact Hours per Week			
	04-10-0	509-vu	Automo	rphic Forms			0		Lecture and 6 Exercise				
2	functio	et L-funct ns, cong	ruence s		oldforms		series, theta s newforms, co	-	•				
3	Studen - under - develo	stand an op an int	nd are ab ermedia		understa	nding	nethods and s of the theor				urse		
4	-		f or Parti Algebra	cipation , Complex A	Analysis								
5	Final M Fachpri when the taken in commu	Module ifung (Te here are n the for inicated	kaminati e Examir echnical only a s m of an	nation (Tech Examinatio mall numbe oral exam. ⁻ he first two	n): Usua er of pote The deci	lly the ential sion a	ation, oral / w e exam is take participants. bout the forr lecture, base	en in form In this ca n of the e	n of a s se, the exam i	written t e exam c s taken a	est, except an be ind		
6	•		on the A hprüfung	ward of Cre	edit Poin	its							
7	Gradin Final M	odule Ex			inical Ex	amina	ation, oral / w	vritten Exa	amina	tion, We	ight: 100%,		
8		-	ik, M.Sc.	e Mathemat	ik, M.Sc.	Math	nematics						

9	Literature
	 D. Bump: Automorphic Forms and Representations, Cambridge University Press A. Deitmar: Automorphe Formen, Springer A. Knapp: Elliptic Curves, Princeton University Press M. Koecher, A. Krieg: Elliptische Funktionen und Modulformen, Springer D. Bump et.al.: An Introduction to the Langlands Programm, Birkhäuser J.H. Bruinier, G. van der Geer, G. Harder, D. Zagier: The 1-2-3 of Modular Forms, Springer
10	Comment recommended: Mathematics: Master (alg)

Мос	lule nam	ne								
	Shim	ura Var	ieties							
Мос	lule no.	Credit F	Points	Workload	Self	-study	Duratio	n	Freque	ency
04-1	.0-0510		5 CP	150 h		105 h	1 Semes	ster	Irregula	ar
-	guage of		ion			on responsib				
-	nan and	-			Prof	. Dr. rer. nat.	Torsten	Burkha	rd Wedl	horn
1	Courses	s of the	Module			1				
	Course no. Course		Course	name		Workload ((CP)	Form Teacl	-	Contact Hours per Week
	04-10-0	510-vu	Shimura	Varieties		0		Lectur Exercis		3
2	Shimura role in t the upp symme	the area per half p tric dom	of inters plane and ains as g	gher-dimensional ge ection of number th d certain quotients, eneralizations. We over, it is planned t	heory mod will g	r, geometry, a ular curves, w ive an interpr	ilgebra, a ve will stu retations	ind ana udy and of cert	alysis. Sta d classify tain quo	arting with hermitian tients as
3	Student - under - develo - are ab	stand ar op an ad ole to ext	nd are ab vanced l cend thei	le to apply the notic evel of understandi r knowledge in this rvised research in th	ng of field	the theory of				ourse
4	-		f or Parti o Algebra	c ipation . Topology (useful)						

5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature S. Helgason: Differential Geometry, Lie groups, and symmetric spaces. Academic Press 1978 S. Kobayashi, K. Nomizu: Foundations of differential geometry I+II, Wiley Classics Library 1996
10	Comment recommended: Mathematics: Master (alg) Selected topic in arithmetic geometry

Мо	dule nam	ne									
	Geor	netric V	ariatior	al Problem	ns						
Мо	dule no.	Credit P	oints	Workload		Self-	study	Duration	1	Frequen	су
04-10-0511 9 CP				270 h	180 h 1 Semester Irregula			Irregular			
Lan	guage of	Instruct	ion			Perse	on responsib	le for the	Modu	ıle	
Ger	man and	English				Prof.	Dr. rer. nat.	Karsten G	iroße-	Brauckma	nn
1	Course	s of the I	Module								
Course no. Course		name			Workload ((CP)	Form Teach	•••	Contact Hours per Week		

6 a of surface s, for critical points ace
s, for critical points ice ions beyond
tandard) test, except can be and number of
/eight: 100%,

Мо	dule nam									
-	Optii dule no. 10-0512			chine Learning Workload 150 h		-study	Duration		Freque Irregula	•
	guage of	Instruct		15011		on responsib	l		_	
	man and					. Dr. rer. nat.			ule	
1			Module		_					
			Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	512-vu	Optimiza	ation in Machine Lear	ning	0		Lectur Exercis		3
3	sparse i Possible Learnin After at which r their pr Studen	ation (su nverse o societa g Outco tending nathema operties ts are ab	novariano l implica mes this cou atical opt le to cor	ector machines), clu ce selection, neural tions will be addres rse, students will ha imization methods ntextualize subject r	netw sed i ive ar are a natte	n the lecture n overview of pplied in this	machine context a	learni and ha	randon ng. They ve learn	n fields v know ed about
4	Requirements for Participation recommended: Introduction to Optimization; useful: Discrete Optimization or Nonlinear Optimization									
5		f Examir odule Ex		on:						
	•	Module	e Examin	ation (Technical Ex	amina	ation, oral / w	ritten Ex	amina	tion, Sta	andard)
	when t	nere are	only a si	Examination): Usua mall number of pote oral exam. The deci	ential	participants.	In this ca	se, the	e exam o	an be

communicated during the first two weeks of the lecture, based on the prospective number of
students taking the exam.
Requirements on the Award of Credit Points
Passing the Fachprüfung
Grading
Final Module Examination:
• Madula Evamination (Technical Evamination and (written Evamination Maight: 100%
Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
Standard)
Usability of the Module
B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
Literature
Mitchell: Machine Learning. Mcgraw-Hill 1997
Murphy: Machine Learning: A Probabilistic Perspective, MIT Press 2012
Sra, Nowozin, Wright: Optimization for Machine Learning, MIT Press, 2012
Miroslav Kubat: An Introduction to Machine Learning.Springer, 2015.
Comment
recommended: Mathematics: Master (opt)

	Onlir	ne Opti	mizatior	1						
Module no. Credit		Points	Workload S		lf-study Duratio		า	Frequency		
04-10-0513 5 CP			150 h	105 h 1 Semester			ter	Irregular		
Language of Instruction					Person responsible for the Module					
Ger	man and	English			Prof.	Dr. Yann Dis	ser			
1 Courses of the Module										
Course no.		no.	Course name					Teaching		Contact Hours per Week
	04-10-0	513-vu	Online C	ptimization		0		Lecture Exercis		3
2		ction to		ptimization, list acc g and online schedu				ine alg	orithm	s, Yao's

3	Learning Outcomes
	Students
	- understand and are able to apply the notions, methods and results treated in the course
	- develop an advanced level of understanding of the formal foundations of online optimization
	and the competitive analysis of online algorithms
	 are able to extend their knowledge in this field
	- are able perform supervised research in this field
4	Requirements for Participation
	recommended: Introduction to Optimization
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Borodin, El-Yaniv. Online Computation and Competitive Analysis. Cambridge University Press,
	Amos Fiat, Gerhard J. Woeginger. Online Algorithms: The State of the Art. Springer, 1998.
10	Comment
	recommended: Mathematics: Master (opt)

Module name

Functional Analysis II

Мос	lule no.	Credit F	Points	Workload		Self-	study	Duration	า	Freque	ncy
04-1	04-10-0515 5 CP 150 h					105 h 1 Semester Irr				rregular	
Lang	guage of	Instruct	ion			Pers	on responsib	le for the	Mod	ule	
Gerr	man and	English				Prof	. Dr. rer. nat.	Reinhard	Farwi	g	
1	Courses	s of the I	Module								
	Course	no.	Course name				Workload (CP)			of hing	Contact Hours per Week
	04-10-0	515-vu	Functional Analysis II				0		Lecture and Exercise		3
2	Study Content Selected topics of linear functional analysis, e.g., spectral calculus of bounded and closed self- adjoint operators; Riesz' representation theorems of positive or continuous linear functionals on C^0; closed operators and definition by forms in Hilbert spaces; perturbation theory; semigroup theory; Bochner spaces; locally convex topological vector spaces										
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an intermediate level of understanding of functional analysis - are able to extend their knowledge in this field Requirements for Participation										
				nal Analysis							
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 										
6	-		on the A hprüfunរ្	ward of Cre	edit Poin	its					
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 							ght: 100%,			
8	Usabilit	ty of the	Module	2							

	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature J. Weidmann: Linear Operators in Hilbert Spaces. Springer 1980 W. Rudin: Real and Complex Analysis. McGraw-Hill 1986 T. Kato: Perturbation Theory for Linear Operators. Springer 1995 K. Yosida: Functional Analysis. Springer 1995 K. Schmüdgen: Unbounded Self-adjoint Operators on Hilbert Space. Springer 2012 D. Werner: Funktionalanalysis. Springer 2000
10	Comment recommended: Mathematics: Master (ana)

				nods	r					
Module no. Credit Points Workload				Self-study Duration			n Freque		•	
04-10-0516 5 CP 150 h			105 h 1 Semest			ster Irregular				
Language of Instruction						on responsib			ıle	
Ger	man and	English			Prof.	Dr. rer. nat.	Jens Lang	8		
1	Courses	s of the l	Module							
	Course no. Co			se name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	516-vu	Reduced	Basis Methods		-		Lecture and 3 Exercise		3
 Reduced basis methods via Galerkin projection: construction, analysis and applicat proper orthogonal decomposition greedy algorithm estimation of the error in the solution and in functional outputs 						pplicati	on			
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of reduced basis methods									
	- are ab	le to ext	end thei	rvised research in th	field		smethod	3		

5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature - Haasdonk: Reduced Basis Methods for Parametrized PDEs A Tutorial Introduction for Stationary and Instationary Problems, IANS, University of Stuttgart, Germany, 2014 - Quarteroni, Manzoni, Negri: Reduced Basis Methods for Partial Differential Equations: An Introduction, Springer, 2016 - Hesthaven, Rozza, Stamm: Certified Reduced Basis Methods for Parametrized Partial Differential Equations, Springer, 2016
10	Comment recommended: Mathematics: Master (num)

Mo	dule nam	ne								
	Mod	ular forms of s	everal varia	bles						
Module no. Credit Points Workload Self-study Duration Frequency									су	
04-10-0517 5 CP 150 h			105 h	1 Semeste	nester Irregular					
Language of Instruction						Person responsible for the Module				
Ger	man and	English	lish Prof. Dr. rer. nat. Jan Hendrik Bruinier							
1	Courses of the Module									
	Course	Course no. Course nam		me		Workload (CP)		Form of Teaching		Contact Hours

					per					
					Week					
	04-10-0517-vu	Modular forms of several variables	0	Lecture and Exercise	3					
2		the theory of modular forms forms or Hilbert modular for		bles for a classical group	o, such as					
3	Students - understand ar - develop an ad variables - are able to ext	 - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of the theory of modular forms of several 								
4	-	for Participation Algebra, recommended: Mo	odular forms or A	Automorphic Forms						
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 									
6	Requirements Passing the Fac	on the Award of Credit Point hprüfung	ts							
7	• Modul	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)								
8	Usability of the B.Sc Mathemat	e Module ik, M.Sc. Mathematik, M.Sc.	Mathematics							
9	van der Geer: H J.H. Bruinier, G.	elsche Modulfunktionen; lilbert modular surfaces; van der Geer, G. Harder, D. oductory lectures on Siegel n	-	3 of modular forms;						

10	Comment
	recommended: Mathematics: Master (alg)
	Selected topic in automorphic forms

Мо	dule no.	Credit F	oints	Workload	Self-study	Duration	ı	Freque	ency
04-	10-0518		5 CP	150 h	105 h	1 Semes	ter	Irregu	lar
Lan	guage of	Instruct	ion		Person responsib	le for the	e Modu	ıle	
Ger	man and	English			Prof. Dr. rer. nat.	Reinhard	l Farwig	5	
1	Course	s of the l	Module						
	Course	no.	Course	name	Workload ((CP)	Form Teach	-	Contac Hours per Week
	04-10-0	518-vu	Selected	Topics in Analysis	0		Lecture Exercis		3
	- stocha - geo-p	astic PDE hysical fl	ows						
	- stocha - geo-p - free b - chemo - Besov	astic PDE hysical fl oundary otaxis spaces	equation s	oblems					
3	- stocha - geo-p - free b - chemo - Besov - pseud Learnin Studen - under - develo - are ab	astic PDE hysical fl oundary otaxis spaces o differe og Outco ts stand an op an ad	equation s ows value pr ential ope mes d are ab vanced le end thei	oblems	ng of a specific top field			n the c	ourse
3	- stocha - geo-p - free b - chema - Besov - pseud Learnin Studen - under - devela - are ab - are ab	astic PDE hysical fl oundary otaxis spaces o differe og Outco ts stand an op an ad ole to ext ole perfo ements f	equation is ows value pr ential ope mes d are ab vanced le end thei rm super	roblems erators le to apply the notion evel of understandi r knowledge in this rvised research in th	ng of a specific top field his field	oic in anal		n the c	ourse

	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (ana)

Mo	dule nam	ne								
	Selec	ted Top	oics in S	tochastics						
Mo	dule no.	Credit F	Points	Workload	Self-	study	Duratior	า	Freque	ncy
04-2	10-0519		5 CP	150 h		105 h	1 Semes	ter	Irregula	ar
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	Modu	ule	
Ger	man and	English			Prof.	Dr. rer. nat.	Michael H	Kohler		
1	Course	s of the	Module							
	Courses of the Module Course no. Course name					Workload ((CP)	Form Teach		Contact Hours per Week
	04-10-0	519-vu	Selected	Topics in Stochastics		0		Lecture Exercis		3
2	Study C	Content								
	-randor -Mallia	n graphs vin calcu	s and geo lus and s	mples include: ometric models in p stochastic analysis. processes	robab	ility				

	- selected chapters in mathematical statistics
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of a specific topic in stochastics - are able to extend their knowledge in this field - are able perform supervised research in this field
4	Requirements for Participation recommended: depending on topic, at least Probability Theory
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (sto)

Module name

Introduction to Algebra and Didactics of Algebra

Moc 04-1 0520		Credit Points Workload			240 h	Self-	study 165 h	Duration 1 Semest		Freque Every 2	ncy . semester
Language of Instruction German							on responsib Dr. phil. nat.			ıle	
1	Courses	s of the	Module								
	Course no. Course name				Workload ((CP)	Form Teach	-	Contact Hours per Week		
	04-00-00	006-vu	Introduc	tion to Algeb	ora		0		Lecture Exercis		3
	04-00-00	039-se		for subject-s : Algebra in s			0		Semina	ar	2
2	skills, co basic kr	on of nu omputer	based le e, learnin	earning, divi	sibility;	typica	tions and ter I student mis nd concepts	sconcepti	ons; de	evelopm	nent of
3	Student		pedagoo	cical content and learning			n algebra and	d number	theory	y and lea	arn to apply
4	Analysis	s, Linear		, Foundatior		-	g and Learnin es is possible	-	nemati	CS	
5		Modul	aminatio e Examin	ation (Study			n, Special For tion, Special		-))
6	-	the Fac		ward of Cre g; passing th			tungen is a p	rerequisit	e for t	aking th	e
7	Grading Final M	odule E> Module Passed)	1	ation (Study	-		n, Special For tion, Special				

8	Usability of the Module Mathematics: Teaching degrees
9	Literature S. Lang: Algebra, Addison-Wesley; N. Jacobson: Basic Algebra 1, Freeman S. Bosch: Algebra, Springer different paper of Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Malle, G. (1993). Didaktische Probleme der elementaren Algebra. Vieweg, Braunschweig/Wiesbaden. topical school books
10	Comment

Мо	dule nan	ne									
	Com	plex An	alysis aı	nd Didactics o	of An	alysi	S				
Module no.				Workload 2	240 h		study 165 h	Duration 1 Semes	-	Freque Every 2	e ncy 2. semester
	guage of man	Instruct	ion				on responsib Dr. phil. nat			ule	
1	Course Course	s of the no.	Module Course	name			Workload ((CP)	Form Teact		Contact Hours per
	04-00-0	159-se		for subject-spe : Analysis in sch			0		Seminar 2		
	04-00-0	225-vu	Complex	Analysis		0 Lecture and 3 Exercise					3
2	analytic Laurent Introdu integra	-Rieman city, Liou t series a ction to I definiti	wille's Th and isolat function	ntial equation leorem and Fu ted singularitie s, analysis of f emann, miscor ogy	indan es, Re uncti	nenta sidue ons, le	l Theorem of Theorem. ocal change c	Algebra; of rate an	Windii d the c	ng Num lefinitio	ber; n of limit,
3	Studen		pedagoo	cical content ki tuations.	nowle	edge i	n analysis an	d learn to	o apply	this in v	various

4	Requirements for Participation Analysis, Linear Algebra, Foundations of Teaching and Learning of Mathematics (participation without certification of prerequisites is possible)
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Standard) Requirements on the Award of Credit Points
	Passing the Fachprüfung; passing the Studienleistungen is a prerequisite for taking the Fachprüfung
8	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Usability of the Module
0	Mathematics: Teaching degrees
9	Literature Freitag: Funktionentheorie I, Springer. Remmert: Funktionentheorie I Conway: Functions of one complex variable, Springer Tietze, UP., Klika,M., Wolpers, HH.: Mathematikunterricht in der SII, Bd. 1, Fachdidaktische Grundfragen, Didaktik der Analysis. Vieweg 2000, Büchter, A., Henn, HW.: Elementare Analysis: Von der Anschauung zur Theorie. Spektrum 2010. Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Kratz, Henrik (2011). Wege zu einem kompetenzorientierten Mathematikunterricht – Ein Studien- und Praxisbuch für die Sekundarstufe. Kallmeyer – Klett, Seelze Gängige Schulbücher
10	Comment

Module nam	ne				
Ordiı	nary Differentia	al Equations and d	ligital media in m	nathematical lo	essons
Module no.	Credit Points	Workload	Self-study	Duration	Frequency

04-1 0522	10- 2/de		8 CP	240 h		165 h	1 Semes	ter	Every 2	2. semester	
Lang	guage of	Instruct	tion		Pers	on responsib	n responsible for the Module				
German Prof. Dr. phil. nat. Katja Krüger											
1	Courses	s of the	Module		J						
	Course no.		rse no. Course name			Workload ((CP)	Form Teacl	-	Contact Hours per Week	
	04-00-0)54-vu	Ordinary	Differential Equation	IS	0		Lectur Exercis		3	
	04-00-02	249-se	didactics	for subject-specific : Digital media in atical lessons		0		Semin	ar	2	
2	systems stability Technic	ion of va s of first v. al feasik cal geon	and high pility, dida	Theorems of Picard er order, variation actical concepts and tware, computer al	of co d app	nstants formu lication exam	ula, linear oples on s	ised st	tability, sheet ar	Lyapunov nalysis,	
3	Student mather	natical s	to use an oftware,	d apply various me calculators, tablet I aching and learning	PCs, i	nteractive wh		-			
4	Analysis of medi	s and Lir a	-	ipation bra and Foundatior ertification of prere		-	-	of Ma	themati	ics, didactics	
5		Modul	kaminatio e Examin	on: ation (Technical Exa ation (Study Examin						(F	
6	-	the Fac		ward of Credit Poin ;; passing the Studie		tungen is a p	rerequisit	te for t	aking th	ne	
7	Gradin ູ Final M ●	odule E>	kaminatic e Examin	on: ation (Technical Exa	amina	ation, Special	Form, W	eight:	100%, S	tandard)	

	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
9	Mathematics: Teaching degrees Literature
	 H. Amann: Gewöhnliche Differentialgleichungen, de Gruyter W.Walther: gew. DGL, Springer Different paper of Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Barzel, B., Hußmann, S., Leuders, T. (2005): Computer, Internet Co. im Mathematik-Unterricht. Cornelsen Verlag Scriptor. paper of "mathematik lehren" and topical school books
10	Comment

Мос	dule nam	ne								
	Elem	entary	Numbe	Theory and Alge	bra i	n schools				
04-1	dule no. .0- 3/de	Credit F	Points 8 CP	Workload 240 h		study 165 h	Duration 1 Semest		Freque Every 4	ncy . semester
Lang Gerr	guage of man	Instruct	ion			on responsib . Dr. phil. nat			ule	
1	Course	s of the	Module							
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	039-se		for subject-specific Algebra in schools		0		Semina	ar	2
	04-10-0	389-vu	Element (Lehram	ary Number Theory t)		0		Lectur Exercis		3
2	Legend Ausblic Probler Zahlber Sekund Schüler	nlen, Prii re-Symb k in Gau n. reichserv arstufen fehler, A	ol, quad ßsche ga weiterun h, Rechne Aufbau vo	erlegung, Kongruer ratische Reziprozitä nze Zahlen, den Dir gen und Behandlun nkönnen, Technolo on Grundvorstellun n für die Entwicklun	it. ichlet g von ogieei gen, N	schen Primza Gleichungen nsatz, Teilbar Nöglichkeiter	ihlsatz od und Tern keitsunte i der Nutz	er das nen in rsuchu ung vo	Fermats den bei ungen; ty on Strate	sche den ypische egien,

3	Learning Outcomes Einführung in die elementare Zahlentheorie und Behandlung einiger klassischer Probleme Die Studierenden erlangen fachliche Sicherheit in schulrelevanten Aspekten der Algebra und Zahlentheorie. beherrschen Darstellungen und Konzepte, um Themengebiete der Algebra in der Schule zu veranschaulichen, sprachsensibel und binnendifferenzierend zu gestalten. können anhand der in den Übungen praktizierten zahlreichen Beispiele Kriterien für intelligentes Üben und Begabtenförderung erläutern und entwickeln ihre diagnostische Kompetenz
4	Requirements for Participation Linear Algebra, Foundations of Teaching and Learning of Mathematics (participation without certification of prerequisites is possible)
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Special Form, Standard) Module Examination (Study Examination, Special Form, Passed / Not Passed)
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistungen is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature A. Beck, M.N. Bleicher, D.W. Crowe: Excursions into Mathematics. Worth Publishers, Inc.1969. B.M.Steward: Theory of Numbers 2nd ed. The Macmillian Company. New York 1964 Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Malle, G. (1993). Didaktische Probleme der elementaren Algebra. Vieweg, Braunschweig/Wiesbaden. Gängige Schulbücher
10	Comment

-		Credit F		Workload	Self-st	idv	Duratio	^	Eroau	nev
.ang	I/de		8 CP	Workload 240 h		•	1 Semes		Freque Every 4	4. semeste
-	.,		0.61	21011		105 11	1 Series		Lvery	. semeste
ierr	uage of	Instruct	tion			responsib			ıle	
	nan				Prof. D	r. phil. nat	. Katja Kr	üger		
•	Courses	s of the	Module							
	Course	no.	Course	name	v	/orkload ((CP)	Form Teach		Contac Hours per Week
	04-00-02	109-se		for subject-specific s: Online task training	0			Semina	ar	2
	04-00-02	144-vu	-	d Foundations (for g Degrees)	0			Lecture Exercis		3
	Die Studierenden erwerben - Fähigkeiten im Lösen und digitalen Dokumentieren von Lösungswegen von Mathematikaufgaben aus verschiedenen schultelevanten									
	Mathematikaufgaben aus verschiedenen schulrelevanten Themenfeldern;									
	- Vorstellungen zur Gestaltung von Arbeitsgemeinschaften mit interessierten Schülern zu									
	-		⁻ hemen;							
	- digitale Feedbacktechniken und Bewusstheit über Problemlöse-strategien und das									
				ener Lösungswege Theorie des Arbeiter	nc mit ^	ufaaban bi	im Labra	n und	larnan	von
	Mathen	-		neone des Arbeiter	ns nin A			.n unu	LEITIEIT	VOIT
	Student		to							
	- solve r	nathem	atical tas	sks in various topics	s found i	n seconda	ry school	curricu	la and o	document
			digitally;							
		-	student							
	- emplo	y mathe	ematical	tasks adequately						
ı	Requirements for Participation basic mathematical knowledge from the first semester,									

	(participation without certification of prerequisites is possible)
5	Form of Examination Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Module Examination (Technical Examination, Special Form, Standard)
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistungen is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature (examples include) Forster, T.: Logic, Induction and Sets. CUP, 234pp., 2003 Kay, R.: The Mathematics of Logic. CUP, 204pp., 2007 Schindler, R.: Logische Grundlagen der Mathematik. Springer, 203pp., 2009 MOODLE-Kurs online mit Skript Barzel, B., Hußmann, S., Leuders, T. (2005): Computer, Internet Co. im Mathematik-Unterricht. Cornelsen Verlag Scriptor.
10	Comment Das Aufgabenpraktikum ist eine online-Veranstaltung mit tutorieller Begleitung.

Module	e nam	ne						
9	Selec	ted Topics in Li	e Algebra T	heory				
Module 04-10- 0526/de		Credit Points 5 CP	Workload	150 h	Self-study	105 h	Duration 1 Semester	Frequency Every 2. semester
Langua Germar	-	Instruction English			-	•	le for the Mod Nils Scheithaue	
		s of the Module						

	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week
	04-10-0526-vu	Selected Topics in Lie Algebra Theory	0	Lecture and Exercise	3
2	Study Content				
	- Representatio - Kac-Moody alg	opics, examples include: n theory of semisimple groups gebras o the theory of vertex algebras			
3	Learning Outco Students	mes			
		nd are able to apply the notions	, methods and results	treated in the co	ourse
		vanced level of understanding of			
		end their knowledge in this fiel			
	- are able perfo	rm supervised research in this f	ield		
4	-	for Participation vithout certification of prerequi	sites is possible)		
5	Form of Examir	nation			
	Final Module Ex	amination:			
	Module	e Examination (Technical Exami	nation, oral / written	Examination, Sta	andard)
	in der Regel erf Klausur	olgt die Prüfung mündlich, bei g	großer Teilnehmerzahl	gegenenfalls du	rch eine
6	Passing the Fac	on the Award of Credit Points hprüfung (normally the exam is e exam can be held as a written		a large number o	of
7	Grading Final Module Ex	amination:			
	• Module Standar	e Examination (Technical Exami ^r d)	nation, oral / written	Examination, We	ight: 100%,
8	Usability of the recommended:	Module Mathematics: Master (alg)			
9	Humphreys: Int Bourbaki: Lie gr Kac: Infinite din	semisimple Lie algebras roduction to Lie algebras and ro oups and Lie algebras nensional Lie algebras bras of finite and affine type	epresentation theory		

	Kac: Vertex algebras for beginners Frenkel, Ben-Zvi: Vertex algebras and algebraic curves
10	Comment

Мо	dule nan	ne									
	Ordi	nary Dif	ferentia	al Equation	s (for N	/lech	anics)				
04-	dule no. 10- 29/de	Credit I	Points 5 CP	Workload	150 h	Self-	study 105 h	Duratio 1 Semes		Frequ e Every	ency 2. semester
	iguage of rman	Instruct	tion	I			on responsib . Dr. rer. nat.				
1	Courses of the Module										
	Course	no.	Course	name			Workload (CP)	Form Teac	-	Contact Hours per Week
	04-00-0	054-vu	Ordinary	y Differential	Equatior	IS	0		Lectur Exercis		3
3	Studen [.] - under	ig Outco ts stand ar	nd are ab				nethods and leory of ordir				
	- are ab	ole to rec	cognise t	he treated c	concepts	s in va	arious fields o	f mathei	matics		
4	Analysi	s and Lir	for Partio near Alge vithout co	ebra	of prere	quisit	es is possible	:)			
5	Final M		kaminati								
	•	Modul	e Examir	nation (Tech	nical Exa	amina		ritten Ex	kamina	tion. St	andard)

	Fachprüfung: In der Regel erfolgt die Prüfung schriftlich durch eine Klausur, bei geringer
	Teilnehmerzahl gegebenenfalls mündlich.
	Studienleistung: In der Regel erfolgreiche Bearbeitung eines Teils der Hausübungen.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung (normally the exam is held orally; in case of a large number of participants the exam can be held as a written test);
	passing the Studienleistung (typically solving a certain amount of home exercises) is a prerequisite for taking the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Applied mechanics
9	Literature
	H. Amann: Gewöhnliche Differentialgleichungen, de Gruyter
	W.Walther: gew. DGL, Springer
10	Comment

Мос	dule nam	ne								
	Semi	nar for	subject	specific didactics	: Alge	bra in scho	ols			
04-1	dule no. LO- D/de	Credit F	Points 3 CP	Workload 90 h		study 60 h	Duration 1 Semes	-	Frequer Every 2.	icy semester
	guage of man Course	Instruct s of the				on responsib Dr. päd. Reg			le	
	Course	no.	Course	name		Workload ((CP)	Form Teach	•	Contact Hours per Week
	04-00-0	039-se		for subject-specific Algebra in schools		0		Semina	ar	2

2	Study Content Zahlbereichserweiterungen und Behandlung von Gleichungen und Termen in den beiden Sekundarstufen, Rechnenkönnen, Technologieeinsatz, Teilbarkeitsuntersuchungen; typische Schülerfehler, Aufbau von Grundvorstellungen, Möglichkeiten der Nutzung von Strategien, Prinzipien und Modellen für die Entwicklung eines Spiralcurriculums bis zur Sekundarstufe II.
3	Learning Outcomes Die Studierenden erlangen fachliche Sicherheit in schulrelevanten Aspekten der Algebra und Zahlentheorie. beherrschen Darstellungen und Konzepte, um Themengebiete der Algebra in der Schule zu veranschaulichen, sprachsensibel und binnendifferenzierend zu gestalten. können anhand der in den Übungen praktizierten zahlreichen Beispiele Kriterien für intelligentes Üben und Begabtenförderung erläutern und entwickeln ihre diagnostische Kompetenz
4	Requirements for Participation Foundations of Teaching and Learning of Mathematics (participation without certification of prerequisites is possible)
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Special Form, Standard) Module Examination (Study Examination, Special Form, Passed / Not Passed)
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature different paper of Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Malle, G. (1993). Didaktische Probleme der elementaren Algebra. Vieweg, Braunschweig/Wiesbaden. topical school books
10	Comment

		nar for	subject	-specific didactics	Analysis in	scho	ols			
	dule no. 10-	Credit I	Points	Workload	Self-study		Duratio	า	Freque	ency
-	31/de		3 CP	90 h	(60 h	1 Semes	ter	Every 2	2. semeste
Lan	guage of	Instruct	ion		Person respo	onsib	le for the	e Modu	ule	
Gei	rman				Prof. Dr. phil					
1	Course	s of the	Module							
	Course	no.	Course	name	Worklo	ad ((CP)	Form Teach		Contact Hours per Week
	04-00-0	159-se		for subject-specific : Analysis in schools	0			Semina	ar	2
3	Loarnin									
	Die Stu …erlan verschi	edene Z	en liche Sich ugänge u	nerheit in besonder Ind Schwerpunktset ngen und Konzepte	zungen geger	neina	nder abv	vägen.		
	Die Stur erlang verschie beher veransc	dierende gen fach edene Zi rrschen I chauliche	en liche Sich ugänge u Darstellu en - auch	nd Schwerpunktset	zungen geger , um Themen Isatzprakti	neina gebie ziere	nder abv ete der Ai	vägen. nalysis	in der S	chule zu
4	Die Stu erlang verschie beher veransc Beispie Require Founda	dierende gen fach edene Zu rrschen I chauliche le für int ements f tions of	en liche Sich ugänge u Darstellu en - auch celligente for Partic Teaching	ind Schwerpunktset ngen und Konzepte mit Technologieeir s Üben, Diagnose u	zungen geger , um Themen isatzprakti: nd Förderung athematics	ieina gebie ziere	nder abv ete der Ai n in den	vägen. nalysis	in der S	chule zu
-	Die Stu erlang verschie behen veransc Beispie Require Founda (partici	dierende gen fach edene Zi rrschen I chauliche le für int ements f tions of pation w	en liche Sich ugänge u Darstellu en - auch celligente for Partic Teaching	ind Schwerpunktset ngen und Konzepte mit Technologieeir s Üben, Diagnose u cipation g and Learning of M ertification of prere	zungen geger , um Themen isatzprakti: nd Förderung athematics	ieina gebie ziere	nder abv ete der Ai n in den	vägen. nalysis	in der S	chule zu
-	Die Stu erlang verschie behen veransc Beispie Require Founda (partici	dierende gen fach edene Zi crschen I chauliche le für int ements f tions of pation w f Examir odule Ex	en liche Sich ugänge u Darstellu en - auch relligente for Partic Teaching vithout co hation kaminatic	ind Schwerpunktset ngen und Konzepte mit Technologieeir s Üben, Diagnose u cipation g and Learning of M ertification of prere	zungen geger , um Themen isatzprakti nd Förderung athematics quisites is pos	neina gebie ziere	nder abv ete der Ai n in den)	vägen. nalysis Übung	in der S en zahlr	chule zu
4	Die Stu erlang verschie behen veransc Beispie Require Founda (partici	dierende gen fach edene Zi rrschen I chauliche le für int ements f tions of pation w f Examir odule Ex	en liche Sich ugänge u Darstellu en - auch celligente for Partic Teaching vithout co hation kaminatic e Examin	ind Schwerpunktset ngen und Konzepte mit Technologieeir s Üben, Diagnose u Cipation g and Learning of M ertification of prere	zungen geger , um Themen asatzprakti nd Förderung athematics quisites is pos	neina gebie ziere sible ecial	nder abv ete der Ai n in den) Form, St	vägen. nalysis Übungo	in der S en zahlr d)	chule zu eiche

7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature Tietze, UP., Klika,M., Wolpers, HH.: Mathematikunterricht in der SII, Bd. 1, Fachdidaktische Grundfragen, Didaktik der Analysis. Vieweg 2000, Büchter, A., Henn, HW.: Elementare Analysis: Von der Anschauung zur Theorie. Spektrum 2010. different paper of Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. topical school books
10	Comment

Мос	dule nan	ne									
	Semi	nar for	subject	-specific didactics	: Stoc	hastic	s in s	chools			
Module no. 04-10- 0532/de		Credit Points 3 CP		Workload 90 h		study	60 h	Duratior 1 Semes			-
-	guage of	Instruct	tion			-		le for the		ule	
	man				Prot.	Dr. ph	il. nat	. Katja Kri	üger		
1	Course	s of the	Module								1
	Course no. Course			name		Workload (CP)			Form of Teaching		Contact Hours per Week
	04-00-0	for subject-specific Stochastics in schoo		0			Semina	ar	2		
2	Study Content History of Probability; History of Statistics; Didactical Analysis of Fundamental Concepts of Probability; Representations of Data; Paradoxes of Probability.										
3	Learnin	g Outco	mes								
	Studen	ts learn t	to explai	n central question c	of stoc	hastic	s in the	eir histori	cal cor	ntext, ana	lyse the

	specific challenges of teaching and learning stochastics in schools, reflect various approaches towards problems in stochastics.
4	Requirements for Participation Foundations of Teaching and Learning of Mathematics, Introduction to Stochastics (participation without certification of prerequisites is possible)
5	Form of Examination Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	 Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Mathematics: Teaching degrees
9	 Literature Victor Katz: A History of Mathematics. Harper Collins, 1993. E. Kaplan, M. Kaplan: Eins zu Tausend. Die Geschichte der Wahrscheinlichkeitsrechnung. Campus Verlag, 2007. C. C. Gillispie: Dictionary of Scientific Biography. Charles Scribner.s Sons, 1970 - 1991. A. Desrosières: Die Politik der großen Zahlen. Eine Geschichte der statistischen Denkweise. Springer, 2005. R. Biehler, J. Engel: Stochastik: Leitidee Daten und Zufall. In R. Bruder, L. Hefendehl-Hebeker, B. Schmidt-Thieme, GG. Weigand (Hrsg.): Handbuch der Mathematikdidaktik, Springer Sprektrum 2015, S. 221 -251. UP. Tietze, M. Klika, H. Wolpers: Mathematikunterricht in der Sekundarstufe II. Band 3:
	Didaktik der Stochastik. Vieweg 2002. HH. Dubben, HP. Beck-Bornholdt: Mit an Wahrscheinlichkeit grenzender Sicherheit: Logisches Denken und Zufall. Rowohlt, 2007.

10	Comment

Mod	lule nam	ie										
	Semi	nar for	subject	specific didactics	: Geo	metry	in scl	nools				
Moc 04-1 0533	-	Credit F	Points 3 CP	Workload 90 h	Self-	study	60 h	Duratio 1 Semes	•		e ncy 2. semester	
Lang Gerr	guage of man	Instruct	ion			-		le for the . Katja Kr		le		
1	Course	s of the	Module									
	Course no.		Course	name		Workl	oad ((CP)	Form of Teaching		Contact Hours per Week	
				for subject-specific s: Geometry in schools		0			Semina	ar	2	
3	and lea Learnin Studen	rning ge g Outco ts attain	ometry. mes pedagoo	ical language in the c								
4	Founda	tions of		Sipation g and Learning of M ertification of prere			ssible)				
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Special Form, Standard) 											
	•	Module	e Examin	ation (Study Examin	natior	n, Specia	al For	m, Passe	ed / No	t Passed	(b)	
6	-	the Facl		ward of Credit Poin g; passing the Studie		tung is a	a prer	equisite ⁻	for taki	ing the		

7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
8	Passed) Usability of the Module Mathematics: Teaching degrees
9	Literature Hattermann/Kadunz/Rezat/Sträßer: Leitidee Raum und Form. In Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Praxis der Mathematik in der Schule (Heft 45): Ausgesprochen Mathe – Sprachen fördern ml 196: Problemlösen lernen in der Geometrie, Seelze Friedrich (2016) Leisen, Josef (2010): Handbuch Sprachförderung im Fach. Varus Verlag Wessel, L.(2015). Fach- und sprachintegrierte Förderung durch Darstellungsvernetzung und Scaffolding. Dortmunder Beiträge zur Entwicklung und Erforschung des Mathematikunterrichts Band 19 (Hrsg. Hußmann; Nührenbörger; Prediger; Selter). SpringerSpektrum
10	Comment

	50111	nar for	subject	-specific didactics	: Digit	tal media ir	mather	natica	l lesson	S
Module no. 04-10- 0534/de		Credit Points 3 CP		Workload 90 h		study 60 h	Duration 1 Semester		Frequency Every semester	
Lan	guage of	Instruc	tion		Perso	on responsik	le for the	Modu	ıle	
Ger	man				Prof.	Dr. phil. nat	. Katja Kri	üger		
1	Courses of the Module									
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week
	didactic			for subject-specific s: Digital media in natical lessons		0		Semina	ar	2
2	Study C	Content			-					
	Technical feasibility, didactical concepts and dynamical geometry software, computer al hardware.						•	•		•

3	Learning Outcomes Die Studierenden erlangen Grundkenntnisse in den gängigsten Mathematikprogrammkategorien, im Umgang mit Taschenrechnern, Tablets, interaktiven Whiteboards und im Programmieren. können Medienanwendungen mit unterschiedlichen didaktischen Konzepten begründen und entwickeln.
4	Requirements for Participation Foundations of Teaching and Learning of Mathematics, didactics of media
	(participation without certification of prerequisites is possible)
5	Form of Examination Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Module Examination (Technical Examination, Special Form, Standard)
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
	• Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature Paper of Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Barzel, B., Hußmann, S., Leuders, T. (2005): Computer, Internet Co. im Mathematik-Unterricht. Cornelsen Verlag Scriptor. Papers of "mathematik lehren" and text books for schools

Module name

	Semi	nar for	subject	-specific didactics	: Onl	ine task trai	ning			
04-1	lule no. .0- 5/de	Credit F	Points 3 CP	Workload 90 h	Self-	Study Duration 60 h 1 Semes				-
_	guage of man and	English				on responsib . Dr. phil. nat			le	
Ţ	Courses of the Module Course no. Course name						of ning	Contact Hours per Week		
	04-00-0	109-se		for subject-specific : Online task training		0		Semina	ar	2
2		on of sub ation, gr		es such as getting to ory, Bezier curves, E						
3	Learning Outcomes Die Studierenden erwerben - Fähigkeiten im Lösen und digitalen Dokumentieren von Lösungswegen von Mathematikaufgaben aus verschiedenen schulrelevanten Themenfeldern; - Vorstellungen zur Gestaltung von Arbeitsgemeinschaften mit interessierten Schülern zu ausgewählten Themen; - digitale Feedbacktechniken und Bewusstheit über Problemlösestrategien und das Lernpotential verschiedener Lösungswege -Handlungswissen zur Theorie des Arbeitens mit Aufgaben beim Lehren und Lernen von Mathematik.									
4	Founda	tions of		c ipation g and Learning of M ertification of prere)			
5	Form of Examination Final Module Examination: • Module Examination (Study Examination, Special Form, Passed / Not Passed) • Module Examination (Technical Examination, Special Form, Standard)									
6	-	the Fac		ward of Credit Poin g; passing the Studie		tung is a prer	equisite f	or taki	ing the	
7	Grading Final Module Examination:									

	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature MOODLE-Kurs online
10	Comment Das Aufgabenpraktikum ist eine online-Veranstaltung mit tutorieller Begleitung.

Mo	dule nam	ne									
	Proje	ect for s	ubject-s	pecific didac	tics:	Dive	rse Learning	Enviror	nment	s	
04-1	dule no. 10- 0/de	Credit Points 6 CP		Workload	load Self 180 h		study 120 h		Duration 1 Semester		ncy . semester
	guage of man	Instruct	ion				on responsib . Dr. phil. nat			ule	
1	Course	s of the	Module								
	Course	no.	Course name				Workload (CP)			of ning	Contact Hours per Week
	04-10-0540-pj		Project for subject-specific didactics: Diverse Learning Environments			0			t	4	
2	inclusic results	pment a on; conce	epts of in earch pr	ation of suppo itial differenti ojects; develo	ation	of lea	arning mathe	matics in	secon	dary scho	ools;
3	Learning Outcomes Students attain - knowledge and skills in long-term development of competencies - experience in analysing and evaluating of learning materials.										
4	•		or Parti o Teaching	c ipation g and Learning	g of M	ather	natics, Practi	se phase			

	-
	(participation without certification of prerequisites is possible)
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Special Form, Standard)
	Addula Evening (Study Evening tion, Consider Depend (Net Depend)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the
	Fachprüfung
_	
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
	Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	Passed)
8	Usability of the Module
	Mathematics: Teaching degrees
9	Literature
	Artikel aus "mathematik lehren" und gängige Schulbücher,
	Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer.
10	Comment
1	

Mo	dule nan	ne									
	Proje	ect for s	ubject-s	pecific did	actics:	Proble	m solving				
04-:	dule no. 10- 1/de	Credit F	Points 6 CP	Workload	180 h	Self-st	•	Duration 1 Semest		Freque Every	ency 4. semester
	guage of man	Instruct	ion				r esponsib r. phil. nat			le	
1	Courses of the Module										
	Course	Course no.		name		M	Workload (CP) Form o Teachi		••	Contact Hours per Week	

	04-00-0043-pj	Project for subject-specific didactics: Problem solving	0	Project	4				
2		and concepts of problem solvi bblem solving; reflection on th	•		ategies and				
3	_		-						
4	Foundations of	for Participation Teaching and Learning of Ma vithout certification of prereq		•					
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Special Form, Standard) Module Examination (Study Examination, Special Form, Passed / Not Passed) 								
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the Fachprüfung								
7		e Examination (Technical Exa e Examination (Study Examin	-	-					
8	Usability of the Mathematics:	e Module Feaching degrees							
9	Literature Bruder,R., Collet,C.: Problemlösenlernen im Mathematikunterricht. Cornelsen Scriptor (2009) Büchter,A., Leuders,T.: Mathematikaufgaben selbst entwickeln. Cornelsen (2005) Polya,G.: Schule des Denkens. Vom Lösen mathematischer Probleme. (1949) Zeitschrift "mathematik lehren": verschiedene Beiträge, Aufgaben aus Mathematikwettbewerben								
10	Comment								

Мо	dule nan	ne									
	Proje	ect for s	ubject-s	pecific didactics:	Appl	ication-orie	nted ma	thema	atical le	essons	
	dule no.	Credit F	Points	Workload	Self	-study	Duration	า	Frequency		
04- 054	10- 12/de		6 CP	180 h		120 h	1 Semes	ter	Every 4	4. semester	
Lan	guage of	Instruct	ion		Person responsible for the Module						
Ger	man				Prof	. Dr. phil. nat	. Katja Kri	üger			
1	Course	s of the	Module			1		1		-	
	Course	Course no. Course name				Workload (CP)		Form Teach		Contact Hours per Week	
	04-00-0113-pj Project for subject-specific didactics: Application-orient mathematical lessons				d O			Project 4		4	
3	reflection Learnin Studen - knowl	on on th g Outco ts attain edge an	e difficul mes d skills ir	otive and normative ty of modeling prob long-term develop g and evaluating of	olems	;; t of competer	ncies		5 UI ITIO	uenng;	
4	Require Founda	ements f	f or Partic Teaching		ather	matics, Practi	se phase				
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, Special Form, Standard) • Module Examination (Study Examination, Special Form, Passed / Not Passed)										
6	-	the Fac		ward of Credit Poin g; passing the Studie		tung is a prer	equisite 1	for taki	ing the		
7	Gradin Final M	-	kaminatio	on:							

	 Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) 								
8	Usability of the Module Mathematics: Teaching degrees								
9	Literature ISTRON-Materialien Bd. 1 - 14 Büchter,A., Leuders,T.: Mathematikaufgaben selbst entwickeln. Cornelsen (2005) Zeitschrift "mathematik lehren": ausgewählte Beiträge Herget/Scholz: Die etwas andere Aufgabe - aus der Zeitung, Kallmeyersche Verlagsbuchhandlung, Seelze 1998 Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer.								
10	Comment								

Мо	dule nam	ne								
	Proje	ect for s	ubject-s	specific didactics:	Asse	ssment of N	lathema	tical (Compete	encies
Module no. 04-10- 0543/de		Points Workload 6 CP 180 H			Self-study D 120 h 1		-	Freque Every 4	ncy . semester	
Language of Instruction German						on responsib . Dr. phil. nat			ule	
1	Course	s of the	Module		_ ,					
	Course no. Cours		Course	name				Form Teacl	•••	Contact Hours per Week
	d		didactics	or subject-specific s: Assessment of atical Competencies		0 Project		t	4	
2	Study Content Reflection on diagnostic abilities; assements and their relation to everyday teaching; development of assessments; diagnosis of typical misconceptions									
3	Studen	g Outco ts attain edge an		n long-term develo	pment	of competer	ncies			

	- experience in analysing and evaluating of learning materials.
4	Requirements for Participation Foundations of Teaching and Learning of Mathematics, Practise phase III (participation without certification of prerequisites is possible)
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Standard)
6	Requirements on the Award of Credit Points Passing the Fachprüfung; passing the Studienleistung is a prerequisite for taking the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
8	Usability of the Module Mathematics: Teaching degrees
9	Literature Baumert et al. PISA 2000, PISA 2003 Relevante Beiträge in Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Fritz, A., Schmidt, S. (Hrsg.). Fördernder Mathematikunterricht in der SEK I. Beltz 2009 Mathematik Lehren 150/2008. Diagnose – Schritte zum Fördern Mathematik Lehren 170/2012. Beurteilen und Bewerten Praxis der Mathematik Heft 15/49 (2007). Diagnose – Schülerleistungen verstehen Praxis der Mathematik Heft 56/56 (2014). Schwierigkeiten in Mathematik begegnen Praxis der Mathematik Heft 63/57 (2015). Klassenarbeiten – prüfen und gestalten
10	Comment Verantwortlich: Frau Krüger (did)

Module name										
Selec	Selected Topics in Numerics									
Module no. 04-10-	Credit Points	Workload	Self-study	Duration	Frequency					

0550	D/de		5 CP	150 h		105 h	1 Semest	ter	Every	2. semester	
Lang Gerr	guage of man	Instruct	tion		Person responsible for the Module Prof. Dr. rer. nat. Jens Lang, Prof. Dr. rer. nat. Jan Giesselmann						
1	Courses	s of the	Module								
	Course no.		Course nam	e		Workload (CP)		Form of Teachin		Contact Hours per Week	
	04-10-0550-vu		Selected Topics in Numeric			0		Lectur Exercis		3	
2	Study Content depending on topic, examples include: - Analysis and numerics of singularly perturbed problems										
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of a topic in numerical analysis - are able to extend their knowledge in this field - are able perform supervised research in this field										
4	-		f or Participati vithout certific	i on cation of prere	quisit	es is possible	.)				
5	Final M • Normal	Modul	kamination: e Examinatior kam is held or	n (Technical Exa ally; in case of							
6	-		on the Award hprüfung	of Credit Poin	ts						
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 										
8		•	Module Mathematics	: Master (num)						
9	Literatı depend	ire ing on to	opic								

ıt				
1	nt	ıt	ıt	ıt

Мос	dule nam	ne								
	Intro	duction	to Lie A	Algebras						
04-1	dule no. 10- 1/de	Credit F	Points 5 CP	Workload 150 h		study 105 h	Duratio 1 Semes		Freque Irregula	-
Lang Geri	guage of man	Instruct	ion			on responsib . Dr. rer. nat.				
1	Course Course		f the Module Course name			Workload (CP)		Form Teach	-	Contact Hours per Week
	04-10-0551-vu Introduction to Lie Algebras					0		Lecture Exercis		3
2 3	Study Content Semisimple Lie algebras, Cartan subalgebras, root systems, structure theory of semisimple Lie algebras, basic principles of the representation theory of semisimple Lie algebras Learning Outcomes									
	The stu	-	ow the s	structure theory of s	semis	imple Lie algo	ebras and	d the ba	asic cond	cepts of the
4	-	ements f nended:	or Partic Algebra	ipation						
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 									
6	Require	ements o	on the Av	ward of Credit Poin	ts					

	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Serre: Complex semisimple Lie algebras, Springer Humphreys: Introduction to Lie algebras and representation theory, Springer Bourbaki: Lie groups and Lie algebras, Springer Carter: Lie algebras of finite and affine type, Cambridge University Press
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

Мос	dule nam	ne										
	Algel	oraic Gr	oups									
	dule no. 10-0552	Credit F	Points 9 CP	Workload 270 h		Self-study Duration 180 h 1 Semes		-	Freque: Irregula	•		
Language of Instruction						Person responsible for the Module						
German and English Prof. Dr. rer. nat. Torsten Burkhard Wedhorn 1 Courses of the Module									iorn			
	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-10-0	552-vu	Algebrai	c Groups		0		Lecture and Exercise		6		
2	Study C Algebra		os, homo	morphisms, linear a	and re	ductive grou	ps or abe	lian va	rieties			
3	Algebraic groups, homomorphisms, linear and reductive groups or abelian varieties Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of the theory of algebraic groups - are able to extend their knowledge in this field											

4	Requirements for Participation recommended: Algebraic Geometry
5	Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature A. Borel: Linear algebraic groups, Springer T. Springer: Linear algebraic groups, Birkhäuser D. Mumford: Abelian varieties, Tata Institute of Fundamental Research
10	Comment recommended: Mathematics: Master (alg)

Mo	dule nam	ne										
	Algel	oraic Cu	rves									
Mo	dule no.	Credit P	oints	Workload		Self-	study	0	Duration		Frequen	су
04-2	10-0553	0-0553 5 CP 150		150 h		105 h 1 Semester		er	Irregular			
Lan	guage of	Instructi	ion			Perso	on respons	sible	e for the N	Modu	le	
Ger	man and	English				Prof.	Dr. rer. na	t. N	lils Scheitl	hauer	-	
1 Courses of the Module												
	Course no. Course name			Workload (CP)			Form of Teaching		Contact Hours			

					per Week
	04-10-0553-vu	Algebraic Curves	0	Lecture and Exercise	3
2		, affine plane curves, pro phisms, rational maps, the			out's
3		re familiar with the basic g. Bezout's theorem and	•	, ,	
4	Requirements recommended:	for Participation			
5	Fachprüfung (T when there are taken in the for	xamination: e Examination (Technical echnical Examination): U e only a small number of p rm of an oral exam. The d during the first two wee	sually the exam is tak potential participants lecision about the for	ken in form of a written . In this case, the exam m of the exam is taken	test, except can be and
6	Requirements Passing the Fac	on the Award of Credit P hprüfung	Points		
7	Grading Final Module Ex Modul Standa	e Examination (Technical	Examination, oral / v	written Examination, We	eight: 100%,
8	Usability of the B.Sc Mathemat				
		e Module .ik, M.Sc. Mathematik, M	.Sc. Mathematics		
9	Hartshorne: Alg		ath.lsa.umich.edu/~v er	vfulton/CurveBook.pdf	

	Intro	duction	to Scie	ntific Programmin	ng 1						
Module no. Credit Points Workload			Workload	Self-	elf-study Duration		n Freque		ency		
04-10- 0554/de			3 CP	90 h		30 h	1 Semes	ter	Every 2	2. semeste	
·					Person responsible for the			Module			
	anguage of Instruction erman					Dr. rer. nat. Andreas Paffenholz, Dr. rer. nat. Alf Gerisch					
1	Course	s of the	Module								
	Course	Course no. Course name		name		Workload ((CP)	Form of Teaching		Contact Hours per Week	
	04-10-0554-vu		Introduction to Scientific Programming 1			0		Lectur Exercis		4	
	functions). - Notions of complexity of algorithms (memory, run time). - Usage of a debugger.										
	- Usage	of a del	ougger.	of algorithms (mem	iory, r	un time).					
3	- Usage Learnin Student They ar	of a deb g Outco ts show e able to	mes basic kno design,	of algorithms (mem owledge of program implement and tes and well-documen	iming t basic	techniques i c mathematic	•	-			
	- Usage Learnin Student They ar laid out	of a deb g Outco ts show e able to ;, well-st	mes basic kno design,	owledge of program implement and tes and well-documen	iming t basic	techniques i c mathematic	•	-			
3 4 5	- Usage Learnin Student They ar laid out Require none Form o	of a deb g Outco ts show e able to , well-st ements f f Examir	mes basic kno basic kno basic kno basign, ructured	owledge of program implement and tes and well-documen cipation	iming t basic	techniques i c mathematic	•	-			
4	- Usage Learnin Student They ar laid out Require none Form o	of a del g Outco ts show e able to ;, well-st ements f f Examir odule Ex	mes basic kno basic kno basic kno basign, ructured for Partic nation caminatic	owledge of program implement and tes and well-documen cipation	iming t basic ted w	techniques i c mathematio ay.	cal algori	thms ir	n a corre	ect, clearly	
4	- Usage Learnin Student They ar laid out Require none Form o Final M	of a del g Outco ts show e able to t, well-st ements f f Examir odule Ex Module	mes basic kno basic kno basic kno basic kno basic nuctured for Partic nation kaminatic e Examir	owledge of program implement and tes and well-documen cipation	nming t basic ted w	techniques i c mathematic ay. n, Special For	cal algori	ed / No	t Passed	d)	

7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik, B.Sc. Angewandte Mechanik, B.Sc. CE
9	Literature Elias Fischer, C-HowTo: Programmieren lernen mit der Programmiersprache C, Books on Demand, ISBN 9783839181041, 2012. Online unter: http://www.c-howto.de/tutorial.html
10	Comment recommended: Mathematics: Bachelor year 1

Мо	dule nan	ne								
	Intro	duction	n to Scie	ntific Programmir	ng 2					
04-:	dule no. LO- 5/de Credit Points 3 CP		Workload 90 h	Self-s	f-study Durati 30 h 1 Sem		•		equency ery 2. semester	
Ger	guage of man				Dr. re	on responsib er. nat. Alf Go nholz				reas
1	Course Course	es of the Module e no. Course name		name		Workload (CP)			of ning	Contact Hours per Week
	04-10-0555-vu Introduc Program		ction to Scientific nming 2		0		Lecture and Exercise		4	
2	 Study Content Introduction into object oriented programming via simple class hierachies in C++. Introduction of the Standard Template Library and its use for advanced data structures (vectors, matrices, queues, stacks). Awareness for problems associated with using floating point arithmetic. Use and implementation of libraries (techniques and examples). Introduction to the programming with Matlab (control structures, functions, vector operations, graphics, mex interface). 									
3	Learning Outcomes Building on EP1, students have a good command of basic techniques of object oriented									

	programming in the programming language C++. They are able to design, implement and test basic mathematical algorithms in a correct, clearly laid out, well-structured and well- documented way. Students are able to include existing code libraries into their program. Building on their acquired programming skills, students can confidently use the Matlab programming environment to implement simple mathematical algorithms.
4	Requirements for Participation recommended: Introduction to Scientific Programming 1
5	Form of Examination Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Successful completion of mathematical and coding assignments. The number of assignments and the
	relevant marking scheme will be announced by the instructor during the first lecture.
6	Requirements on the Award of Credit Points Passing the Studienleistung
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	B.Sc. Mathematik, B.Sc. Angewandte Mechanik, B.Sc. CE
9	Literature - J. Pitt-Francis J Whiteley, Guide to Scientific Computing in C++, Springer-Verlag London, ISBN 9781447127352, 2012. - B. Stroustrup, The C++ Programming Language, 4th Edition, Addison-Wesley, ISBN 9780321563842, 2013. - The C++ Ressources Network. Online: http://www.cplusplus.com/ - Matlab Online Documentation, The Mathworks. Online: http://de.mathworks.com/help/matlab/index.html

Module name

Distributions

04-1	Module no. 04-10- 0556/de		Points 5 CP	Workload	150 h	Self-	study 105 h	Duration 1 Semest		Frequency Irregular	
	guage of man	Instruct	ion				o n responsik Dr. rer. nat.				
1	Course	s of the	Module								
	Course	no.	Course	Course name			Workload (- /	Form of Teaching		Contact Hours per Week
	04-10-0	556-vu	Distribut	ions			0		Lecture Exercis		3
2	Study C Spaces		' and S a	nd S'; Fourie	er transf	orm, f	undamenta	solutions,	, Sobo	lev spa	ces
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of the theory of distributions - are able to recognise the treated concepts in various fields of mathematics.										
4	-		f or Partic Function	c ipation nal Analysis							
5	Final M Fachpri when the taken in commu	Module üfung (Te here are n the for inicated	camination e Examir echnical only a si m of an o	nation (Tech Examinatior mall numbe pral exam. T ne first two	n): Usua r of pote The deci	lly the ential sion a	tion, oral / v exam is tak participants bout the for ecture, base	en in form . In this cas m of the e	of a v se, the xam is	written e exam s taken	test, except can be and
6	-		on the A hprüfun៖	ward of Cre	dit Poin	ts					
7	Grading Final M	odule Ex			nical Ex	amina	tion, oral / v	vritten Exa	minat	ion, We	eight: 100%
8		•	tik, M.Sc	Mathemati	k, M.Sc.	Math	ematics				

9	Literature
	 W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999. W. Walter, Distributionen J. Duistermaat, Distributions, Springer, 2010. M. Renardy, R.C. Rogers: An Introduction to Partial Differential Equations, Second Edition, 2004, 1993, Springer.
10	Comment recommended: Mathematics: Bachelor year 3 (ana)

Мо	dule nam Distr	ne ibution:	<u> </u>									
04-1	Module no.Credit Points04-10-5 CP		Workload	Workload Self		study Duration		•		-		
Lang Engl	guage of lish	Instruct	ion				on responsib . Dr. rer. nat.					
1	Courses of the M Course no.			Iodule Course name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0556-vu Distribu			ions			0		Lectur Exercis		3	
2	Study C Spaces		' and S a	nd S'; Fourier	transf	orm,	fundamental	solution	s, Sobo	olev spac	ces	
3	Studen - under - develo	stand ar op a basi	nd are ab ic level o	le to apply the f understandi he treated co	ng of t	the th	eory of distri	butions		in the co	ourse	
4	-		for Partic Analysis	ipation , Ordinary Dif	feretia	al Equ	lations, Comp	olex Anal	ysis, Int	tegratio	n Theory	
5			aminatio	on: ation (Techni	ical Exa	amina	ation, oral / w	vritten Ex	aminat	tion, Sta	andard)	

	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999. W. Walter, Distributionen J. Duistermaat, Distributions, Springer, 2010. M. Renardy, R.C. Rogers: An Introduction to Partial Differential Equations, Second Edition, 2004, 1993, Springer.
10	Comment recommended: Mathematics: Bachelor year 3 (ana)

Мо	dule nam	ne											
	Intro	ductior	to Rep	resentation	Theo	ſy							
Module no. 04-10- 0558/deCredit Points 5 CPWorkload150 h				Self-s	•	Duration 1 Semester		Frequency Irregular					
	man	an Courses of the Module					Person responsible for the Module Prof. Dr. rer. nat. Nils Scheithauer						
	Course	Course no. Course		name			Workload ((CP)	Form Teach		Contact Hours per Week		
	04-10-0	04-10-0558-vu Introduction to Representatio Theory				'n	0		Lecture Exercis		3		

2	Study Content Representations of finite groups, characters, induced representations, group algebra, rationality questions, projective representations, representations of compact groups
3	Learning Outcomes The students understand and are able to apply the notions, methods and results treated in the course. They have a basic understanding of the representation theory of finite groups and are able to recognise the treated concepts in various fields of mathematics.
4	Requirements for Participation recommended: Introduction to algebra
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Serre: Linear representations of finite groups, Springer Thomas: Representations of finite and Lie Groups, Imperial College Press Isaacs: Character theory of finite groups, Dover Fulton, Harris: Representation theory, Springer
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

Мо	dule nam	ne								
	Ellipt	ic Curve	es							
04-:	odule no. 1-10- 159/de Credit Points Workload 5 CP 150		Workload 150 h	Self-study 105 h	Duration 1 Semes	•		-		
	guage of man	Instruct	ion		Person responsib Prof. Dr. rer. nat.					
1	Course	s of the I	Module							
	Course no.		Course	name	Workload ((CP)	Form Teach	-	Contact Hours per Week	
	04-10-0	559-vu	Elliptic C	urves	0		Lecture Exercis		3	
2	Study Content Projective curves, Bezout's Theorem, Weierstrass equations, j-invariant, group law, Mordell- Weil group, elliptic curves over finite fields, torsion, Mordell's Theorem, complex uniformization.									
3	Studen - under - develo - are ab	stand an op a basi le to rec	nd are ab c level o cognise tl	le to apply the notion f understanding of t the treated concepts	he theory of ellipt	ic curves		n the cc	ourse	
4	-		or Partic Complex	Analysis, Introduct	tion to Algebra					
5			aminatio							
	• Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.									
6	-		on the Av	ward of Credit Poin	ts					
7	Gradin	3								

	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature A. Knapp: Elliptic curves; J. Silverman: Rational points on elliptic curves; J. Silverman: The arithmetic of elliptic curves
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

Mod	lule nam	ne									
	Ellipt	ic Curv	es								
Mod 04-1 0559	•	Credit Points 5 CP		Workload	150 h	,		Duration 1 Semester		Frequency Irregular	
Lang Engl	guage of ish	Instruct	ion				on responsib Dr. rer. nat.				
1	Course	s of the	Module								
	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0	559-vu	Elliptic C	urves			0	Lecture and Exercise		3	
2	-	ive curve	-	it's Theorem, es over finite						•	
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of the theory of elliptic curves - are able to recognise the treated concepts in various fields of mathematics.										
4	Require	ements f	for Partio	cipation							

1
recommended: Complex Analysis, Introduction to Algebra
Form of Examination
Final Module Examination:
• Module Examination (Technical Examination, oral / written Examination, Standard)
Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
Requirements on the Award of Credit Points
Passing the Fachprüfung
Grading
Final Module Examination:
 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
Usability of the Module
B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
Literature
A. Knapp: Elliptic curves;
J. Silverman: Rational points on elliptic curves; J. Silverman: The arithmetic of elliptic curves
13. Siverman. The antimetic of emptic curves
Comment
recommended: Mathematics: Bachelor year 3 (alg)

Мо	dule nam	ne										
	Arith	metic G	ieometi	y I								
Module no. Credit Points		Workload		Self-s	study	Duration	า	Freque	ency			
04-2	10-0560		5 CP		150 h		105 h	1 Semes	ter	Irregular		
Lan	guage of	Instruct	ion			Person responsible for the Module						
Ger	man and	English				Prof. Dr. rer. nat. Torsten Burkhard Wedhorn						
1	Course	s of the I	Module									
	Course	no.	Course	name		Workload		CP)	Form of Teaching		Contact Hours per	

					Week						
	04-10-0560-vu	Arithmetic Geometry I	0	Lecture and Exercise	3						
2	Study Content Moduli spaces, deformation theory, moduli spaces of curves, moduli spaces of abelian varieties										
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an intermediate level of understanding of arithmetical geometry										
4	-	for Participation Algebraic Geometry									
5	Fachprüfung (T when there are taken in the for	kamination: e Examination (Technical Exa echnical Examination): Usua only a small number of pote m of an oral exam. The deci during the first two weeks o	lly the exam is t ential participar sion about the f	aken in form of a written hts. In this case, the exam form of the exam is taken	test, except can be and						
6	Requirements Passing the Fac	on the Award of Credit Poin hprüfung	ts								
7	Grading Final Module Ex • Modul Standa	e Examination (Technical Exa	amination, oral	/ written Examination, We	eight: 100%,						
8	Usability of the B.Sc Mathemat	e Module ik, M.Sc. Mathematik, M.Sc.	Mathematics								
9	Literature M. Olsson: Algebraic Stacks, AMS G. Laumon: Champs algebriques, Springer J. de Jong, etal: Stacks project, http://stacks.math.columbia.edu/										
10	Comment recommended:	Mathematics: Master (alg)									

Мос	lule nam	ne								
	Intro	duction	to Lie /	Algebras						
Moc 04-1 0562	-	Credit F	Points 5 CP	Workload 150 h	Self-	study 105 h	Duration 1 Semes	-	Freque Irregula	-
Lang Engl		Instruct	ion			on responsib . Dr. rer. nat.				
1	Course	s of the I	Module					-		
	Course	no.	Course	name		Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-10-0	561-vu	Introduc	tion to Lie Algebras		0		Lectur Exercis		3
2 3	Study Content Semisimple Lie algebras, Cartan subalgebras, root systems, structure theory of semisimple Lie algebras, basic principles of the representation theory of semisimple Lie algebras Learning Outcomes									
		dents kr		structure theory of	semis	imple Lie algo	ebras and	the ba	asic conc	epts of the
4	-		or Parti Algebra	ipation						
5			aminatio		amina	ation, oral / w	vritten Ex	aminat	tion, Sta	ndard)
	 Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 									
6	-		on the A hprüfung	ward of Credit Poin	ts					
7	Gradin Final M	-	aminatio	on:						

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Serre: Complex semisimple Lie algebras, Springer Humphreys: Introduction to Lie algebras and representation theory, Springer Bourbaki: Lie groups and Lie algebras, Springer Carter: Lie algebras of finite and affine type, Cambridge University Press
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

Мос	dule nan	ne										
	Intro	duction	to Rep	resentation	Theo	r y				-		
04-1	dule no. 10- 2/en	Credit I	Points 5 CP	Workload	150 h	Self-	study 105 h	Duration 1 Semester		Frequency Irregular		
Lang Engl	guage of lish	Instruct	ion			Person responsible for the Module Prof. Dr. rer. nat. Nils Scheithauer						
1 Courses of the Module												
	Course	Irse no. Course name				Workload (CP)		CP)	Form of Teaching		Contact Hours per Week	
	04-10-0562-vu		Introduction to Representatio Theory		'n	0		Lecture and Exercise		3		
2		entation		e groups, cha presentations			•			algebra,	rationality	
3	Learning Outcomes The students understand and are able to apply the notions, methods and results treated in the course. They have a basic understanding of the representation theory of finite groups and are able to recognise the treated concepts in various fields of mathematics.											
4	•		f or Partic Introduc	cipation ction to algeb	ra							

5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature
	Serre: Linear representations of finite groups, Springer
	Thomas: Representations of finite and Lie Groups, Imperial College Press Isaacs: Character theory of finite groups, Dover
	Fulton, Harris: Representation theory, Springer
10	Comment
	recommended: Mathematics: Bachelor year 3 (alg)

Мо	dule nan	ne										
	Mod	ular For	ms									
04-:	dule no. 10- 3/de	Credit P	oints 5 CP	Workload	150 h	Self-s	•	5 h	Duration 1 Semeste	r	Freque Irregula	•
	guage of man	Instruct	ion			Person responsible for the Module Prof. Dr. rer. nat. Jan Hendrik Bruinier						
1	Course	s of the I	Module									
	Course no.		Course	name			Workload (CP) Form o Teachir			Contact Hours per		

	-				•							
						Week						
	04-10-0563-vu	Modular Forms	0		Lecture and Exercise	3						
2	Study Content Modular group, modular forms, valence formula, the algebra of modular forms, Eisenstein series, theta series, Hecke operators, L-functions, sums of squares											
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of the theory of modular forms - are able to recognise the treated concepts in various fields of mathematics.											
4	Requirements for Participation recommended: Complex Analysis, Einführung in die Algebra											
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 											
6	Requirements of Passing the Fac	on the Award of Credit Po hprüfung	bints									
7	Grading Final Module Ex Modul Standa	e Examination (Technical	Examination, oral /	[/] written Exa	amination, We	eight: 100%,						
8	Usability of the B.Sc. Mathema	e Module tik, M.Sc Mathematik, M.S	Sc. Mathematics									
9	Literature Freitag, Busam: Funktionentheorie 1; Serre: A course in arithmetic; A. Knapp: Elliptic curves											
10	Comment recommended:	Mathematics: Bachelor y	ear 3 (alg)									

Мо	dule nam	ne									
	Mod	ular For	ms								
04-2	dule no.	Credit F		Workload 150 h		Self-study Duration 105 h 1 Semes		• •		-	
Lan	guage of	Instruct	ion		Person responsible for the Module						
Eng	lish				Prof.	Dr. rer. nat.	Jan Hend	lrik Bru	iinier		
1	Course	s of the l	Module								
	Course no.		Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week	
	04-10-0	563-vu	Modular	Forms	(0		Lecture Exercis		3	
2	Study Content Modular group, modular forms, valence formula, the algebra of modular forms, Eisenstein series, theta series, Hecke operators, L-functions, sums of squares										
3	Student - under - develo - are ab	stand an op a basi le to rec	d are ab c level o	le to apply the notion f understanding of the treated concepts cipation	the the	eory of modu	ular form	s	n the co	ourse	
-	-			k Analysis, Einführu	ng in d	lie Algebra					
5		f Examin odule Ex	ation aminatio	on:							
	•	Module	e Examin	ation (Technical Ex	amina	tion, oral / w	vritten Ex	aminat	tion, Sta	andard)	
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.										
6	Requirements on the Award of Credit Points Passing the Fachprüfung										
7	Gradin	B									

	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Freitag, Busam: Funktionentheorie 1; Serre: A course in arithmetic; A. Knapp: Elliptic curves
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

Мос	dule nam	ne								
	Arith	metical	Geome	etry II						
Мос	dule no.	Credit F	Points	Workload	Self-study Duratio			n Frequency		ncy
04-1	0-0564	5 CP 150 h 105 h 1 Semester Irregular				ar				
Lang	Language of Instruction					on responsib	le for the	e Modu	ule	
Gerr	man and	English			Prof	. Dr. rer. nat.	Torsten I	Burkha	rd Wedl	norn
1	Course	s of the	Module							
	Course	Course no.		name		Workload (CP)		Form Teach	•.	Contact Hours per Week
	04-10-0564-vu		Arithmetical Geometry II			0		Lecture and Exercise		3
2	Study C algebra		, quotier	nt stacks, Artin crite	eria					
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of arithmetical geometry - are able to extend their knowledge in this field									
4	•		or Partic Algebrai	ipation ic Geometry						

—	
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
_	Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature M. Olsson: Algebraic Stacks, AMS G. Laumon: Champs algebriques, Springer J. de Jong, etal: Stacks project, http://stacks.math.columbia.edu/
10	Comment recommended: Mathematics: Master (alg)

Мос	dule nan	ne									
	Real	and cor	nplex m	anifolds							
04-1	dule no. 10- 5/en	Credit I	Points 9 CP	Workload 270		Self-study 180 h	Duratio		Freque Irregul	-	
						Person responsible for the Module Prof. Dr. rer. nat. Karsten Große-Brauckmann					
1	Course	s of the	Module								
	Course no. Course		name		Workload ((CP) Forr Tead		•••	Contact Hours per Week		
	04-10-0	565-vu	Real and	complex manifold	ls	0		Lectur	e and	6	

				Exercise	
2	Study Content		<u> </u>		L
	Prerequisites from Point-set top topology. Algebraic topology: c Differentiability, tangent bundle theorem. Further topics such as	onnectedness, fu , submanifolds.	Indamental group, cov Integration of differen	verings. Manifol Itial forms and S	ds: Stokes
3	Learning Outcomes Students can decide which conc They are able to describe them	•		e invariantly fo	rmulated.
4	Requirements for Participation recommended: Analysis, Linear integration.	Algebra, comple	x analysis, ordinary dif	ferential equati	ions,
5	Form of Examination Final Module Examination:				
	Module Examination (T	echnical Examin	ation, oral / written Ex	amination, Sta	ndard)
	Fachprüfung (Technical Examina when there are only a small nun taken in the form of an oral exac communicated during the first t students taking the exam.	nber of potentia m. The decision a	participants. In this ca about the form of the e	ase, the exam ca exam is taken a	an be nd
6	Requirements on the Award of Passing the Fachprüfung	Credit Points			
7	Grading Final Module Examination: • Module Examination (T Standard)	echnical Examin	ation, oral / written Ex	amination, Wei	ight: 100%,
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathen	natik, M.Sc. Mat	hematics		
9	Literature Lee: Introduction to smooth Ma Warner: Foundations of differer Farkas, Kra: Riemann surfaces		and Lie groups		
10	Comment recommended: Mathematics: B	achelor year 3 (g	eo)		

Мо	dule nam	ne								
	Selec	ted Top	oics in O	ptimization						
Мо	dule no.	Credit F	Points	Workload	Self-	study	Duratio	n	Freque	ncy
04-:	10-0566		5 CP	150 h		105 h	1 Semes	ter	Irregula	ar
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ıle	
Ger	man and	English			Prof	. Dr. rer. nat.	Stefan U	lbrich		
1	Courses of the Module					T				
	Course	no.	Course name			Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-10-0	04-10-0566-vu Selected Topics in Optimizat			on	0		Lecture Exercis		3
2	Study C depend	Content ling on to	opic							
	- develo - are ab	stand ar op an ad le to ext	vanced lo cend thei	le to apply the noti evel of understandi r knowledge in this rvised research in th	ng of field	a specific top				ourse
4	-		f or Partic dependi	ipation ng on topic, at leas	t Intro	oduction to C	ptimizati	on		
5			aminatio	on: ation (Technical Ex	amina	ation, oral / w	vritten Ex	aminat	tion, Sta	andard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, ex when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.								an be	
6	-		on the Av	ward of Credit Poin	ts					
7	Grading	3								

	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (opt)

Мо	dule no.	Credit F	oints	Workload	Self-	study	Duration	n	Frequ	ency
04-	4-10-0567 5 CP 150		150 h		105 h	1 Semest	ster Irregu		ılar	
						on responsib			ıle	
	1	•			Prot.	Dr. rer. nat.	Ulrich Re	it		
1	Courses of the Module					1		1		
	Course no. Course		Course	name		Workload ((CP)	Form Teach		Contact Hours per Week
			Selected topics in geometry and approximation				Lecture Exercis	ecture and 3 kercise		
2	* Spline * Non-l * Appro * Image * Wave * harm * relativ * geom	tion but approx inear sul oximatio process lets onic map vity theo	imation odidivsic n and sm sing os ry tial diffe		d-valu	ied data				
3	Studen			le to apply the notic	ons n	nethods and	rosults tra	aatad i	n the c	0.1150

	- develop an advanced level of understanding of a specific topic in geometry or approximation
	- are able to extend their knowledge in this field
	- are able perform supervised research in this field
4	Requirements for Participation
	recommended: typically Differential geometry
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Master (geo)

Мо	Module name									
Selected topics in geometry and approximation										
Мо	dule no.	Credit Points	Workload		Self-study	Duration	Frequency			
04-1	0-0568	9 CP		270 h	180 h	1 Semester	Irregular			
Lang	guage of	Instruction			Person responsi	ole for the Mod	ule			
Geri	man and	English			Prof. Dr. rer. nat	Ulrich Reif				
1	L Courses of the Module									

	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week			
	04-10-0568-vu	Selected topics in geometry and approximation	0	Lecture and Exercise	6			
2	Study Content To mention but some examples: * Spline approximation of PDEs * Non-linear subdidivision * Approximation and smoothing of manifold-valued data * Image processing * Wavelets * harmonic maps * relativity theory * geometric partial differential equations * Lie groups, etc.							
3	 develop an ad are able to ext are able perfo Requirements f 	nd are able to apply the notions, vanced level of understanding c tend their knowledge in this field rm supervised research in this fi for Participation	f a specific topic in go d					
	recommended:	typically Differential geometry						
5	Final Module Ex Module Fachprüfung (To when there are taken in the for	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 						
6	Requirements of Passing the Fac	on the Award of Credit Points hprüfung						
7	Grading Final Module Ex Module Standar	e Examination (Technical Exami	nation, oral / written	Examination, W	eight: 100%,			

8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (geo)

Мо	dule no.	Credit F		Workload		f-study	Duratio	n	Freque	-
04-	10-0569		5 CP	150	h	105 h 1 Semester Irregular				
	guage of man and		ion			son responsib of. Dr. rer. nat.				
1	Course	s of the	Module							
	Course	no.	Course	name		Workload ((CP)	Form Teach	•.	Contac Hours per Week
	04-10-0	569-vu	Class fiel	ld theory		0		Lecture and Exercise		3
2		ology of	•	oups, local class fi y, ideles, idele cla			procity l	aw, glo	bal clas	s field
	Cohom theory,	ology of global r	eciprocit	• •			procity l	aw, glo	bal clas	s field
	Cohom theory,	ology of global r g Outco	eciprocit	• •			procity l	aw, glo	bal clas	s field
	Cohom theory, Learnin Studen - under	ology of global r g Outco ts stand ar	eciprocit mes id are ab	y, ideles, idele cla	ss gro	up methods and	results tr	eated i	in the c	
	Cohom theory, Learnin Studen - under - develo	ology of global r g Outco ts stand ar op an ad	eciprocit mes Id are ab	y, ideles, idele cla le to apply the no evel of understan	ss gro tions, ding o	up methods and f the theory of	results tr	eated i	in the c	
	Cohom theory, Learnin Studen - under - develo - are ab	ology of global r g Outco ts stand ar op an ad le to ext	eciprocit mes Id are ab vanced lo rend thei	y, ideles, idele cla	tions, ding o	up methods and f the theory of	results tr	eated i	in the c	
3	Cohom theory, Learnin Studen - under - develo - are ab - are ab - are ab	ology of global r g Outco ts stand ar op an ad ile to ext ile perfo ements f	eciprocit mes Id are ab vanced lo rend thei rm super	y, ideles, idele cla le to apply the no evel of understan r knowledge in th rvised research in	tions, ding o is fielc this fi	up methods and f the theory of	results tr	eated i	in the c	
3	Cohom theory, Learnin Studen - under - develo - are ab - are ab - are ab	ology of global r g Outco ts stand ar op an ad ile to ext ile perfo ements f	eciprocit mes Id are ab vanced lo rend thei rm super	y, ideles, idele cla le to apply the no evel of understan r knowledge in th rvised research in	tions, ding o is fielc this fi	up methods and f the theory of	results tr	eated i	in the c	
3	Cohom theory, Student - under - develo - are ab - are ab recomm	ology of global r g Outco ts stand ar op an ad ile to ext ile perfo ements f	eciprocit mes Id are ab vanced lo rend thei rm super for Partic Algebrai	y, ideles, idele cla le to apply the no evel of understan r knowledge in th rvised research in	tions, ding o is fielc this fi	up methods and f the theory of	results tr	eated i	in the c	
2 3 4 5	Cohom theory, Learnin Studen - under - develo - are ab - are ab - are ab recomn	ology of global r g Outco ts stand ar op an ad le to ext le perfo ements f nended: f Examir	eciprocit mes Id are ab vanced lo rend thei rm super for Partic Algebrai	y, ideles, idele cla le to apply the no evel of understan r knowledge in th rvised research in cipation ic Number Theory	tions, ding o is fielc this fi	up methods and f the theory of	results tr	eated i	in the c	

	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature N. Childress: Class field theory; D. Cox: Primes of the form x^2+ny^2; J. Neukirch: Algebraische Zahlentheorie; J. Milne: Class Field Theory; J. Neukirch: Klassenkörpertheorie
10	Comment recommended: Mathematics: Master (alg) Selected topic in number theory

Мо	dule nam	ne									
	Linea	r Algeb	raic Gro	oups							
Mo	dule no.	Credit F	Points	Workload		Self-	study	Duration	า	Frequer	ncy
04-1	10-0570		5 CP		150 h		105 h	1 Semes	ter	Irregula	r
	guage of man and		ion				on responsib . Dr. rer. nat.				orn
1	Courses of the Module										
	Course no. Course name				Workload ((CP)	Form Teach	•••	Contact Hours per Week		
	04-10-0	570-vu	Linear Al	gebraic Group	DS		0		Lecture Exercis		3

2	Study Content Linear algebraic groups as matrix groups, structure theory, classification
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of the theory of linear algebraic groups - are able to extend their knowledge in this field - are able perform supervised research in this field
4	Requirements for Participation recommended: Algebraic Geometry
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature A. Borel: Linear algebraic groups, Springer T. Springer: Linear algebraic groups, Birkhäuser
10	Comment recommended: Mathematics: Master (alg) Selected topic in algebraic geometry

Mo	dule nam									
04-:	Selec dule no. 10- '1/en	Credit F		omputational Log Workload 150 h		f-study Duratio 105 h 1 Seme		• •		•
Lan	guage of lish	Instruct	ion			on responsib				
1	Courses of the Module									
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-10-0	571-vu	Selected Logic	Topics in Computation	onal	0		Lectur Exercis		3
2		ding on t		ictor, this course tre higher types, game					-	ns etc.
3	Studen - under - develo - are ab	stand an op an ad ole to ext	id are ab vanced l end thei	le to apply the notic evel of understandi r knowledge in this rvised research in th	ng of field	a specific top				
4	-		or Parti o dependi	-						
5	 recommended: depending on topic Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 									
6	Requirements on the Award of Credit Points Passing the Fachprüfung									

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (log)

Мос	dule nan	ne									
	Selec	ted Top	bics in L	ogic and Co	mplex	ity					
04-1	dule no. .0- 2/en	Credit F	Points 5 CP	Workload	Sel f 150 h		study 105 h	Duratio 1 Semes	-	Frequency Irregular	
Lanք Engl	guage of ish	Instruct	ion				on responsib . Dr. rer. nat.			ule	
1	Course	s of the	Module								
	Course no.		Course name			Workload (CP)			Form of Teaching		Contact Hours per Week
	04-10-0572-vu		Selected Topics in Logic and Complexity			0			Lecture and Exercise		3
2	algorith structu	d topics nmic com re and co	nplexity of omplexit	of problems f	From lo lassifica	gic ar	ues of decida d/or the ana of problems	lysis by lo	ogical r	nethods	of the
3	Studen course. comple	They ha xity theo	stand an ive devel ory. They	oped an adv	anced l extend	evel o their	otions, metho of understand knowledge ir	ding of a s	specifi	c topic in	logic and

4	Requirements for Participation
	recommended: depending on topic
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
•	
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment recommended: Mathematics: Master (log)

Мос	dule nan	ne										
	Selec	ted Topi	cs in Lo	ogic and Fo	undati	ons						
04-1	Module no. 04-10- 0573/enCredit Points 5 CPWorkload 150				150 h		study	105 h	Duration 1 Semest		Frequency Irregular	
Lang Engl		Instructio	on			Person responsible for the Module Prof. Dr. rer. nat. Thomas Streicher						
1	Course	s of the N	1odule									
Course		no. Course name			Workload (CP)		CP)) Form of Teaching		Contact Hours per		

						Week						
	04-10-0573-vu	Selected Topics in Logic and Foundations	0		Lecture and Exercise	3						
2		he lecturer there will be given y type theory, synthetic differ			ructive type t	heory, linear						
3	- develop an ad - are able to ext	nd are able to apply the notion vanced level of understanding tend their knowledge in this fi rm supervised research in this	g of a specific t eld									
4		Requirements for Participation recommended: depending on topic										
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.											
6	Requirements Passing the Fac	on the Award of Credit Points hprüfung	;									
7	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)											
8	Usability of the B.Sc Mathemat	e Module ik, M.Sc. Mathematik, M.Sc. N	1 a the matics									
9	Literature depending on t	opic										
10	Comment recommended:	Mathematics: Master (log)										

NO	dule nam Stati		· stocha	stic processes									
	dule no. 10-0574			Workload 270 h		- study 180 h	Duration 1 Semes		Freque Irregula	-			
	guage of	Instruct				on responsib	l		-				
Ger	man and	English			Dr. r	er. nat. Corn	elia Wich	elhaus					
1	Course	s of the	Module										
	Course no.		Course name			Workload (CP)		Form Teach	-	Contact Hours per Week			
	04-10-0	574-vu	Statistics	s for stochastic proces	ses	0	Lectur Exercis		6				
2	Study Content Weak convergence in Polish spaces, Theory of convergence in (C(0,1), sup), Theorem of Donsker, Parametric statistical methods for queueing systems, Theory of Bayes, Nonparametric statistical approaches for stochastic networks, theorems of functional convergence												
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of statistical methods for stochastic processes - are able to extend their knowledge in this field - are able perform supervised research in this field												
4	-		f or Partic Mathem	cipation natical Statistics									
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 												
 6 Requirements on the Award of Credit Points Passing the Fachprüfung 													

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Klenke, Wahrscheinlichkeitstheorie Billingsley, Converngence of probability measures
10	Comment recommended: Mathematics: Master (sto)

	Stock	nastic p	rocesse	s IIB							
Mo	dule no.	Credit I	Points	Workload	Self-	study	Duratio	on Freque		ency	
)4-2	LO-0575		9 CP	270 h		180 h	1 Semes	ter	Irregula	ar	
Lan	guage of	Instruct	tion		Pers	on responsib	le for the	e Modu	ule		
Ger	man and	English			Prof.	Dr. rer. nat.	Volker M	lartin B	Betz		
L	Course	s of the	Module								
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0575-vu		Stochastische Prozesse IIB		0			Lecture and Exercise		6	
	a							Exercis	e		
2		al mech		d interacting particl scaling limits, mod	•	•	-	, contir	nuous ti		
	statistic chains, Learnin	cal mech Gibbs m g Outco	ieasures,	•	•	•	-	, contir	nuous ti		
2	statistic chains, Learnin Studen	cal mech Gibbs m g Outco	neasures, o mes	scaling limits, mod	els an	d results from	n statisti	, contir cal mee	nuous ti chanics.		
	statistic chains, Learnin Studen - under	cal mech Gibbs m g Outco ts stand ar	neasures, m es nd are ab	•	els an	d results from	n statistic	, contir cal med	nuous ti chanics.		
	statistic chains, Learnin Studen - under - develo	cal mech Gibbs m g Outco ts stand ar op an ad	neasures, n mes nd are ab	scaling limits, mod	els an	d results from	n statistic	, contir cal med	nuous ti chanics.		

 recommended: Stochastic Processes I Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be
 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
• Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
Requirements on the Award of Credit Points
Passing the Fachprüfung
 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
Literature Liggett: interacting particle systems Friedli, Velenik: Statistical mechanics of Lattice Systems
Comment

Mo	dule nam	ie									
	Stock	nastic pi	rocesses	s IIC							
Module no. Credit Points Workload			Self-study		Duration		Frequency				
04-10-0576 9 CP			270 h	180 h 1 Semest			ter Irregular				
Lan	guage of	Instruct	ion			Perso	on responsib	le for the	Modu	ıle	
Ger	man and	English				Prof.	Dr. rer. nat.	Frank Au	zada		
1	Courses	s of the I	Module								
	Course	rse no. Course		name			Workload ((CP)) Form of Teachin		Contact Hours per Week

	04-10-0576-vu	tochastic processes IIC	0	Lecture and Exercise	6					
2			• •	obabilities, first passage tii n, long range dependence						
3	- develop an adva - are able to exte		ing of the theor field	and results treated in the c ry of stochastic processes	ourse					
4	Requirements fo recommended: S	r Participation tochastic Processes I								
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 									
6	Requirements or Passing the Fach	1 the Award of Credit Poi prüfung	nts							
7	Grading Final Module Exa • Module Standard	Examination (Technical Ex	amination, ora	l / written Examination, W	eight: 100%,					
8	Usability of the N B.Sc Mathematik	Module , M.Sc. Mathematik, M.Sc	. Mathematics							
9	Literature depending on top	pic								
10	Comment recommended: N	Nathematics: Master (sto)								

	Stock	nastic p	rocesse	s IID									
Мо	dule no.	Credit F	oints	Workload	Self-st	tudy	Duration	า	Freque	ency			
04-	10-0577		9 CP	270 h		180 h	1 Semes	ter	Irregul	ar			
Lan	guage of	Instruct	ion		Perso	n responsib	le for the	e Modu	ule				
Ger	man and	English			Prof. [Dr. rer. nat.	Volker M	artin E	Betz				
1	Course	s of the I	Module										
	Course	no.	Course name			Workload (CP)			of ning	Contact Hours per Week			
	04-10-0577-vu Sto			ic processes IID	0			Lectur Exercis		6			
	Study Content Stochastic differential equations and rough paths: rough path norms, existence of rough Brownian motion, Stratonovich and Ito rough paths, existence and continuity of rough integration, solutions to rough differential equations, introduction to the theory of regularity structures.												
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of the theory of stochastic processes - are able to extend their knowledge in this field - are able perform supervised research in this field												
4			or Partic Stochas	cipation tic Processes I									
5	Final M	Module	aminatio e Examir	ation (Technical Exa									
	when the taken in commu	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.											
6	Requirements on the Award of Credit Points Passing the Fachprüfung												

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Friz, Hairer: A course on rough paths
10	Comment recommended: Mathematics: Master (sto)

Мо	dule nam	ne									
	Stock	nastic p	rocesse	s IIE							
Мо	dule no.	Credit F	Points	Workload	Self-study Duration			n Frequency		ency	
04-10-0578 9 CP 270 h				180 h 1 Semes			ster Irregular				
Language of Instruction					Pers	on responsib	le for the	e Modi	ule		
Ger	man and	English			Dr. r	er. nat. Corne	elia Wich	elhaus			
1	Course	s of the	Module								
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0578-vu		Stochastic processes IIE		0		Lecture and Exercise		6		
2	Study C	Study Content									
	Markov	Markov processes in continuous time									
	-Poisson processes and general point processes										
	 general theory of time series and important examples stochastic queueing systems: models and important properties 										
3	Learning Outcomes										
	Students										
	- under	- understand and are able to apply the notions, methods and results treated in the course									
		- develop an advanced level of understanding of the theory, properties and possibilities of									
		applications of various stochastic processes									
		- are able to extend their knowledge in this field									
	- are ab	- are able to perform supervised research in this field									

4	Requirements for Participation recommended: Stochastic Processes I
5	Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Klenke: Wahrscheinlichkeitstheorie Daley, Vere-Jones: An Introduction to the Theory of Point Processes Asmussen: Applied Probability and Queues
10	Comment recommended: Mathematics: Master (sto)

Module name												
Computational Complexity												
Module no. Credit Points Workload					Self-	elf-study Duration			1	Frequency		
04-2	4-10-0579 9 CP 270		270 h			180 h	1 Semester		Irregular			
Language of Instruction						Person responsible for the Module						
Ger	man and	English				Dr. rer. nat. Kord Eickmeyer						
1	1 Courses of the Module											
	Course no. Course		name			Workload (CP)		CP)	Form of Teaching		Contact Hours	

			per						
					Week				
	04-10-0579-vu	Computational Complexity	0	Lecture and Exercise	6				
2	Study Content								
	computational complexity (models of computation, reducibility, hardness and completeness, approximability, randomised complexity, parameterised complexity)								
3	Learning Outco Students	omes							
		nd are able to apply the notio	ns, methods and	d results treated in the c	ourse				
	- develop an ad	lvanced level of understandin	g of computatio	nal complexity theory					
	- are able to ext	tend their knowledge in this f	ield						
4	Requirements	for Participation							
	recommended:	linear algebra							
5	Form of Examir	nation							
	Final Module Examination:								
	Module Examination (Technical Examination, oral / written Examination, Standard)								
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except								
	when there are only a small number of potential participants. In this case, the exam can be								
	taken in the form of an oral exam. The decision about the form of the exam is taken and								
	communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.								
6		on the Award of Credit Point	S						
	Passing the Fac	hprüfung							
7	Grading Final Module Examination:								
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 								
8	Usability of the								
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics								
9	Literature								
	Sanjeev Arora, Boaz Barak: Computational Complexity, Cambridge University Press; Christos Papadimitriou: Computational Complexity, Pearson; Vijay Vazirani: Approximation Algorithms,								
	Springer; Jörg Flum, Martin Grohe: Parameterized Complexity; Springer								
10	Comment		2 (1)						
	recommended: Mathematics: Bachelor year 3 (log)								
		Mathematics. Bachelor year	5 (108)						

Мо	dule nan	ne									
	Selec	ted Top	oics in A	lgebra							
Module no. Credit Points Workload			Self-stu	Self-study Duration		n	Freque	ency			
04-10-0580 9 CP 270 h			180 h 1 Semes			ster Irregular					
Lan	guage of	Instruct	ion		Person	responsib	le for the	e Modu	ule		
Ger	man and	English			Prof. Dr	. rer. nat.	Torsten I	Burkha	rd Wed	horn	
1	Course	Courses of the Module									
	Course no. Cou			urse name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0	580-vu	Selected	Topics od Algebra	0				ecture and 6 xercise		
	and Lie	algebra	s, Adic Sp	, for instance Linear baces, Arakelov Inte	-	•	•		nology,	Lie groups	
3		g Outco tending		rse, students will kn	now a cur	rent rese	arch field	within	algebra	3	
4	-		f or Partic Algebra	Sipation Analysis, Algebraic	: Geomet	ry or Alge	braic Nu	mber T	heory		
5	Final M • Fachpri when ti taken in	Module ifung (Te here are n the for	kamination e Examir echnical only a si m of an o	on: lation (Technical Exa Examination): Usua mall number of pote oral exam. The decis ne first two weeks o	lly the ex ential par sion abor	am is take ticipants. ut the form	en in forr In this ca m of the c	n of a v ase, the exam is	written t e exam o s taken a	test, except can be and	
6			the exar	n. ward of Credit Poin	its						
-	•		hprüfun								
7	Gradin Final M	-	kaminatio	on:							

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature differs
10	Comment recommended: Mathematics: Master year 1 or 2

Мо	dule nan	ne								
	-			robability Theory Workload		at du	Duratio		F	
	Module no.Credit PointsWorkload04-10-05819 CP270 H				Self-	study 180 h	1 Semes		Freque Irregula	-
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modi	ule	
Ger	man and	English			Prof	. Dr. rer. nat.	Burkhard	d Kümn	nerer	
1	Course	s of the	Module							
Course		no.	Course	name		Workload (CP)	Form of Teaching		Contact Hours per Week
	04-10-0	581-vu	Operato Theory	algebraic Probability		0		Lecture and Exercise		6
2	- opera - tensol - compl - quant - classic	ral theoy tor alget r produc etely po um syste cal and q	oras ts sitive op ems uantum	erators stochastic processe dynamical systems	S					
3	Learning Outcomes Students know and understand the concepts, methods, and results taught and can apply them. They have a deeper understanding of subareas of operator algebras and quantum probability theory, depending on the specific topics. They are able to augment their knowledge in this area independently and to pursue research questions in it under guidance.									
4	Require	ements	or Partio	cipation						

-	
	Functional analysis and, depending on the specific topics, parts probability theory, stochastic processes, quantum mechanics
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Bestehen der Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B. Sc. Mathematik, M. Sc. Mathematik, M.Sc. Mathematics
9	Literature M. Takesaki: Theory of Operator Algebras I, II, III B. Blackadar: Operator Algebras D. Applebaum et al.: Quantum Independent Increment Processes I,II Further literature depending on the topics
10	Comment More detailed information on the choice of topics, requirements and literature can be found at the beginning of the semester in TUCaN.

Мос	Module name										
	Selected Topics of Geometry										
Мос	lule no.	Credit Points	Workload		Self-study	Duration	Frequency				
04-1	0-0582	5 CP		150 h	105 h	1 Semester	Irregular				
Lang	guage of	Instruction			Person responsible for the Module						
Gerr	man and	English			Prof. Dr. rer. nat. Karsten Große-Brauckmann						
1	Courses of the Module										

		1										
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week							
	04-10-0582-vu	Selected Topics in Geometry	0	Lecture and Exercise	3							
2	Study Content											
3	Students have s research area G	Learning Outcomes Students have studied a specific topic of the research area Geometry and Approximation and can apply their insights to solve problems.										
4	Requirements fas specified by	for Participation lecturer										
5	Final Module Ex Module Fachprüfung (To when there are taken in the for communicated	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 										
6	Requirements Passing the Fac	on the Award of Credit Points hprüfung										
7	Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)											
8	Usability of the LaG Mathemati	e Module ik, M.Sc. Mathematik, M.Sc M	athematics									
9	Literature to be specified	in class										
10	Comment recommended	for Master										

Mo	dule nam								
	Selec dule no. 10-0583	-		Workload 150 h		Duratio	ster		e ncy 2. semester
Ger	guage of man				Person responsi Prof. Dr. rer. nat Giesselmann				nat. Jan
1			Course	name	Workload	Workload (CP)		of ning	Contact Hours per Week
	04-10-0	583-vu	Selected	Topics in Numerics 2	0		Lectur Exercis		3
2	Study Content Topic dependent, examples include: - Analysis and numerics of singularly perturbed problems								
3	Student and car They ar	apply t e able to	and und hem. The	erstand the terms, r ey have a deepened their knowledge in idance.	understanding o	f an area	of the t	heory o	f numerics.
4	-		or Partic vithout co	cipation ertification of prere	quisites is possibl	e)			
5	Form of Examination Final Module Examination:								
	Module Examination (Technical Examination, oral / written Examination, Standard)								
Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, examine there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number students taking the exam.								can be and	
6	Require	ements o	on the A	ward of Credit Poin	ts				
7	Gradin	g							

	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module recommended: Mathematics: Master (num)
9	Literature depending on topic
10	Comment

Мо	dule nan Stati	-	or Cogni	tive Science						
Мо	dule no.			Workload	Self-	study	Duration	า	Freque	ncy
04-2	10-0584		6 CP	180 h		120 h	1 Semes	ter	Every 2. semeste	
Lan	guage of	Instruct	tion		Pers	on responsib	le for the	e Modu	ule	
Ger	man				Prof.	. Dr. rer. nat.	Frank Au	rzada		
1	Course	s of the	Module							
	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0594-vu S ¹		Statistic	s I Cognitive Science				Lecture and Exercise		4
2	of prob momer estimat	tive stat ability (r nts); estin cors); tes	andom v mators (sting (hyp	llecting and represe variables, combinate samples, central lim pothesis testing, sign test, distribution te	orics, it the nificai	distribution a orem. point a nce, error of	and their and interv	val		
3	Learning Outcomes Vermittlung eines breiten Grundlagenwissens in der mathematischen Statistik mit dem Ziel, Entscheidungen unter Unsicherheit im technischen, unternehmerischem oder volkswirtschaftlichem Management zu ermöglichen. Die Studierenden sollen typische statistische Probleme des Schätzens und Testens in technischen, betriebswirtschaftlichen und ökonomischen Fragestellungen									

	Analysen von Spezialisten aufbereiten können.
4	Requirements for Participation
	keine
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Pflicht
9	Literature Bamberg, G., Bauer, F., Krapp, M.: Statistik, 13. Aufl., Oldenbourg, München, 2007 Fahrmeir, L., Künstler, R., Pigeot, I. Tutz, G.: Statistik -Der Weg zur Datenanalyse. 4. Aufl., Springer, Berlin 2003 Schira, J., Statistische Methoden der VWL und BWL: Theorie und Praxis, 2. Aufl., München usw., Pearson Studium, 2005
10	Comment Verantwortlich: Herr Aurzada (sto)

Мо	dule nam	ne									
	Algel	oraic Topo	logy								
Module no. Credit Points Workload				Self-study	Duration	Freque	ncy				
04-10-0585 9 CP			270 h	180 h	180 h 1 Semester		Irregular				
Language of Instruction						Person responsible for the Module					
Eng	glish					Prof. Dr. rer. nat. Torsten Burkhard Wedhorn					
1	Courses	s of the Mo	dule								
	Course	no. Co	ourse	name		Workload (,	n of ching	Contact Hours per Week		

	04-10-0585	Algebraic Topology	0	Lecture and Exercise	6					
2	2 Study Content Basic of Algebraic Topology: Homotopy, fundamental groupoid, homology, cohomology, fibrations									
3	Learning Outco The students le	omes earn to cope with the basics	of algebraic topolog	39						
4	Requirements for Participation Recommended: Linear Algebra, Analysis, Introduction to Algebra									
5	Fachprüfung (T when there are taken in the for	xamination: e Examination (Technical Ex echnical Examination): Usua only a small number of pot rm of an oral exam. The dec during the first two weeks o	ally the exam is take ential participants. ision about the form	n in form of a written In this case, the exam n of the exam is taken	test, except can be and					
6	Requirements Passing the Fac	on the Award of Credit Poir	nts							
7	Grading Final Module Ex Modul Standa	e Examination (Technical Ex	amination, oral / w	ritten Examination, Wo	eight: 100%,					
8	Usability of the M.Sc Mathema	Module tik, M.Sc. Mathematics, LAC	6 Mathematik							
9	Literature P. May: Concise	e Algebraic Topology; tom D	ieck: Algebraic Topo	blogy						
10	Comment									

Module name

Mathematical Statistical Mechanics

	dule no.	Credit F		Workload			study	Duratio	•		-
	LO-0586		9 CP		270 h		180 h	-	rregular		
	guage of	Instruct	ion				on responsib				
	lish					Prof	. Dr. rer. nat.	Volker IV	lartin	Betz	
1	Courses of the Module Course no. Course			e name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	04-10-0586 Mathematical Statistical Mechanics					0		Lectur Exerci		6
2	subject models limits, p	study m to noise like the bhase tra	e. The mo Potts m	ost prominer odel. For the , correlation	nt exam se mod	ple is lels, v	ems of many the Ising mo ve will consid thermodyna	del, but v er the qu	ve wil estior	l also co n of infir	nsider othei nite volume
3	In this of microsoc cases. Y	opic effo ou will l	ou will le ects, and earn to e	l how mathe use and find	matics correla	can d tion i	ehaviour eme escribe and p nequalities, a the many im	brove this key tool	phen to stu	omenor Idy thes	n in simple e otherwise
4	-			cipation 'ahrscheinlich	hkeitsth	neorie	2				
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 										
6	-		on the A hprüfung	ward of Crec g;	dit Poin	ts					
7	Gradinı Final M	odule Ex			nical Exa	amina	ation, oral / w	vritten Ex	amina	ition, W	eight: 100%,

8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature 1) Sacha Friedli and Yvan Velenik: Statistical Mechanics of Lattice Systems, Cambridge University Press 2017. 2) Hugo Duminil-Copin: Graphical Representations of Lattice Spin Models, availabe from his home page.
10	Comment

Мо	dule nam									
-	dule no.		Points	tromagnetics Workload	Self	study	Duratio		Freque	-
-	10-0587	1	9 CP	270 h	D		1 Semes		Irregula	ar
	guage of ilish	Instruct	lon			on responsib Dr. Kersten Sc			Jie	
1	1	s of the	Module		100					
-	Course		Course	name		Workload ((CP)	Form Teach		Contact Hours per Week
	04-10-0	587-vu	Computa	ational Electromagnet	ics	0		Lecture and Exercise		6
	current	model,	Maxwell	s in electromagneti equations), variatic nd Numerical Analy	onal f	•			•	•
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of the solution theory for electromagnetic problems and Galerkin discretizations									
4	-		or Partic e in num	ipation erics and partial dif	feren	tial equation	S			
5		f Examir odule E>	nation caminatio	on:						

	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Madula Evanination (Tachnical Evanination, and (written Evanination, Maight, 100%
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Step devide
	Standard)
8	Usability of the Module
	M.Sc.Mathematik, M.Sc.Mathematics
9	Literature
	Monk, Finite Element Methods for Maxwell's Equations, Oxford Scientific Publications, Alonso-
	Rodriguez, Valli, Eddy Current Approximation of Maxwell Equations: Theory, Algorithms and
	Applications, Springer, Braess, Finite Elements, Springe
10	Comment

Мо	dule nam	ne										
	Com	binator	ial Optir	nization								
Мо	dule no.	Credit I	Points	Workload		Self-s	study	Duratio	n	Freque	ncy	
04-	10-0588		5 CP	150	0 h		150 h	1 Semes	Semester Irregu		ular	
Language of Instruction English 1 Courses of the Module						Person responsible for the Module Prof. Dr. Yann Disser						
	Courses of the Module Course no. Course name				Workload ((CP)	Form Teach	•.	Contact Hours per Week			
	04-10-0	588-vu	Combina	torial Optimizatio	n		0		Lecture Exercis		0	

2	Study Content shortest paths (advanced), maximum flows (advanced), min-cost maximum flows, maximum matchings, complexity
3	Learning Outcomes The students know and understand the concepts and methods taught in the course and can apply them. They have a thorough understanding of the formal foundations of combinatorial optimization. They are able to independently expand their knowledge of the field and pursue supervised research projects.
4	Requirements for Participation Recommended: Introduction to Optimization, ADM
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated by the instructor during the first lecture. during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M. Sc. Mathematik and Mathematics, B Sc. Mathematik (3rd year)
9	Literature Korte, Vygen. Combinatorial Optimization. Springer, 2012.
10	Comment

Мо	dule nan	ne								
	Alge	braic Ge	ometry	11						
Мо	dule no.	Credit F	oints	Workload	dy	Duratio	n	Freque	ency	
04-	10-0589		9 CP	270 h		180 h	1 Semes	ter	Irregul	ar
Lan	guage of	Instruct	ion		Person	responsib	le for the	e Modu	ıle	
Ger	man and	English			Prof. Dr	. rer. nat.	Torsten l	Burkha	rd Wed	horn
1	Course	s of the l	Module							
	Course	no.	Course	name	W	orkload ((CP)	Form Teach	-	Contact Hours per Week
	04-10-0	589-vu	Algebrai	c Geometry II	0			Lecture Exercis		6
	algebra	and the cohomology of schemes, in particular homological algebra and derived functors, cohomology of affine schemes and of projective space, and duality.								
3	Studen - under treated - develo and the - are ab	stand an i in the c op an ad eir cohon ole to ext	d are ab ourse vanced la nology end thei	le to apply the notive evel of understandi r knowledge in this rvised research in th	ng of sch field			isms,		
4	-	ements f mended:		ipation ic Geometry						
5	Final M	Form of Examination Final Module Examination:								
	of pote	the exai ntial par	m is take ticipants	ation (Technical Ex n in form of a writt . In this case, the ex of the exam is take	en test, e kam can b	except wh be taken i	en there n the for	are on	ly a sma	all number

	during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M.Sc.Math and M.SC Mathematics
9	Literature Hartshorne: Algebraic Geometry Grothendieck et al.: EGA and SGA Stacks Authors: The Stacks project
10	Comment

Мос	dule nam	ne								
	Non-	Acaden	nic Inter	nship						
04-1	dule no. .0- D/de	Credit F	Points 5 CP	Workload 150 h		study 150 h	Duratior 1 Semes		Freque Irregula	•
Lang Gerr	guage of man	Instruct	ion			on responsib iendekan*in				
1	Courses of the Module									
	Course no. Course name					Workload (CP) Form of Teachin			•	Contact Hours per Week
2	Study Content volunteering or internship in a company or a extra-academic institution in a location reflecting the potential future work environment of a mathematics student.									
3	Learnin	g Outco	mes							
	The stu	dents ex	perience	e a realistic working	envir	onment for r	nathema	ticians	. They ca	an work in

	teams and have an idea how mathematicians may work and can report on it.
4	Requirements for Participation
	empfohlen: Pflichtmodule des 1. und 2. Studienjahres
	In der Regel werden Praktikumsplätze auf Eigeninitiative der Studierenden gefunden. Damit ein Praktikum anerkannt werden kann, muss es sich hinreichend für den Studiengang eignen. Die Eignung des Praktikums muss von einer Dozentin/einem Dozenten des Fachbereichs Mathematik anerkannt werden, die/der dann auch den Schein ausstellt.
5	Form of Examination
	Final Module Examination:
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Studienleistung: Bericht und/oder Vortrag bei mitbetreuender Dozentin/mitbetreuendem
	Dozenten des Fachbereichs
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	Bachelor Mathematik PO 2018, Studium Generale, not for Master of Science Mathematik or Mathematics
9	Literature
10	Comment

Module name										
Selected Topics in Algebra										
Module no.	Credit Points	Workload		Self-study	Duration	Frequency				
04-10-0591	5 CP		150 h	105 h	1 Semester	Irregular				
Language of	Instruction			Person responsible for the Module						
German and	English			Prof. Dr. rer. nat.	Torsten Burkha	rd Wedhorn				

1	Courses of the Module									
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week					
	04-10-0590-vu	Selected Topics in Algebra	0	Lecture and Exercise	3					
2	Study Content Current topic in algebra, for instance Linear Algebraic Groups, proetale cohomology, Lie groups and Lie algebras, Adic Spaces, Arakelov Intersection Theory, Moduli Spaces									
3	Learning Outcomes After attending this course, students will know a current research field within algebra									
4	-	for Participation : Algebra, Analysis, Algebraic	Geometry or Algebraic	Number Theory						
5	Usually the exa of potential pa decision about		en test, except when the am can be taken in the n and communicated	ere are only a sm form of an oral e	all number xam. The					
6	Requirements Passing the Fac	on the Award of Credit Poin chprüfung;	ts							
7	Grading Final Module E • Modu Standa	le Examination (Technical Exa	amination, oral / written	Examination, W	eight: 100%,					
8	Usability of the M.Sc. Mathem	e Module atik, M.Sc. Mathematics, LAG								
9	Literature									
	to be announce	ed at the beginning of the se	mester							

	Appli	ed Stat	istics in	Human Sciences									
Module no. Credit Points Workload Self-study Duration										ency			
)4-	10-0592		8 CP	240 h		165 h	1 Semes	ter	Every 2	2. semeste			
an	guage of	Instruct	ion		Person	responsib	le for the	e Modu	ule				
Gei	man				Prof. D	r. rer. nat.	Michael I	Kohler					
1	Course	ourses of the Module											
	Course no.		Course name		M	Workload (CP)		Teaching Ho		Contact Hours per Week			
	04-10-0	592-vu	Applied Sciences	Statistics in Human	0			Lectur Exercis		5			
2	Study C	ontent											
	Fragest	Folgende Lerninhalte werden anhand beispielhafter humanwissenschaftlicher Fragestellungen erläutert: 1. Erhebung von Daten im Rahmen von Studien und Umfragen											
	2. Besc	2. Beschreibende Statistik											
	Histogr - Statist (Arithm und Int	 Graphische Darstellung von Daten mit Hilfe von Säulendiagrammen, Histogrammen und Boxplots Statistische Maßzahlen, insbesondere Maße der zentralen Tendenz (Arithmetisches Mittel, Median) und Dispersion (Varianz, Standardabweichung und Interquartilsabstand) Lineare Regression, Kovarianz und Korrelation 											
	3. Das mathematische Modell des Zufalls												
 - Der Begriff der Wahrscheinlichkeit, das empirische Gesetz der großen Zahlen - Wahrscheinlichkeitsmaße - Zufallsvariablen und Verteilungen - Erwartungswert und Varianz - Unabhängigkeit, - Gesetz der großen Zahlen und zentraler Grenzwertsatz 													
	4. Statis	stische T	estverfa	hren									
	Betafeh (Stichpi	iler, Vor obengrö	gehen be öße, Effe	sts (Hypothesenbild ei Signifikanztests, G ktstärke, Power)) st, F-Test, Chiquadr	Brenzen	von Signifi			nd				

3	Learning Outcomes
	Die Studierenden verfügen über ein grundlegendes Verständnis für das
	Konzept des Zufalls und darauf aufbauender statistischer Schlussweisen.
	Sie haben ein Konzept zu statistischen Maßzahlen, der zentralen Tendenz
	und der Dispersion. Sie verstehen das Prinzip eines statistischen
	Signifikanztests, können gängige statistische Tests auf humanwissenschaftliche
	Fragestellungen anwenden und kennen die Grenzen von Signifikanzaussagen.
	Sie verstehen die Prinzipien von Korrelation und linearer
	Regression und können Korrelation von Kausalität unterscheiden.
4	Requirements for Participation
5	Form of Examination
	Final Module Examination:
	• Module Examination (Study Examination, Written Exam, Duration 90 min, Standard)
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	• Module Examination (Study Examination, Written Exam, Weight: 100%, Standard)
8	Usability of the Module
9	Literature
	Judith Eckle-Kohler, Michael Kohler.
	Eine Einführung in die Statistik und ihre Anwendungen.
	3. Auflage, Springer, 2017
10	Comment

Module name										
Statistics for Economics										
Module no.	Credit Points	Workload		Self-study	Duration	Frequency				
04-10-0593										
Language of	Instruction			Person responsil	ble for the Modu	ıle				

Ger	man		Prof. Dr. rer. nat. F	- rank Aurzada	
1	Courses of the	Module	•		
	Course no.	Course name	Workload (C	P) Form of Teaching	Contact Hours per Week
	04-10-0593-vu	Statistics for Economics	0	Lecture and Exercise	3
2		tistics, probability calculus fidence intervals, hypothe		istributions, limit theo	orems, point
3	 describe the l conduct the r apply statistic recognize the 	e the students are able to basics of descriptive and in main operations of probab cal estimation and testing relevance of statistical an ults of statistical analyses	nductive statistics. vility calculus. procedures correctly. valyses for business ar	nd economic problem	
4	-	for Participation Mathematik I and II			
5			Examination, oral / wi	ritten Examination, D	uration 90
6	Requirements	on the Award of Credit Po	pints		
7	Grading Final Module E • Modul Standa	e Examination (Technical	Examination, oral / wi	ritten Examination, W	/eight: 100%,
8	Usability of the Wirtschaftsinge	e Module enieurwesen and Wirtscha	aftsinformatik (Bachel	or)	
9	Fahrmeir L. et a	aur, F., Krapp, M.: Statistik al.: Statistik: Der Weg zur I hematik für Ingenieure un	Datenanalyse	er, Band 3	

Мо	dule nam	ne									
	Selec	ted Top	oics in Lo	ogic							
Мо	dule no.	Credit P	oints	Workload		Self-s	study	Duratio	n Frequency		ency
04-	10-0594		9 CP		270 h		270 h	1 Semes	ter	Irregul	ar
Lan	guage of	Instruct	ion			Perso	on responsib	le for the	e Modu	ıle	
Ger	man and	English				Prof.	Dr. phil. nat.	Ulrich K	ohlenb	ach	
1	Course	Courses of the Module									
	Course no.		Course name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0591-vu Selected Topics in Logic					0		Lecture Exercis		0	
3	comput	g Outco	neory in	ctor, this cou higher types,						-	ms etc.
	- under - develo - are ab	stand an op an ad [,] le to ext	vanced le end thei	le to apply th evel of under r knowledge rvised researd	rstandii in this	ng of a field	a specific top				
4	Require	ements f	or Partic	ipation							
5	Final M • Fachpri numbei exam. 1	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung: Usually the exam is taken in form of an oral exam, except when there are bigger number of potential participants. In this case, the exam can be taken in the form of a written exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 									
6	Require	ements o	n tha Au	ward of Crod							

	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on the topic
10	Comment recommended: Mathematics: Master (log)

Мос	dule nam	ne									
	Grap	h Theo	ry								
04-1	Module no.Credit PointsWork04-10-9 CP9 CP0595/en9 CP9 CP				270 h	Self-	Self-study Duratio 270 h 1 Semes				
Language of Instruction English							on responsib er. nat. Kord			le	
1	Courses of the Course no.		Module Course	name		Workload (CP		CP)	Form of Teaching		Contact Hours per Week
	04-10-0	595-vu	Graph Tl	neory			0		Lecture and Exercise		0
2	Study C Graphs theory		tivity, co	lourability, ex	xtrema	ıl grap	bh theory, Ra	msey the	ory, gr	aph strı	ucture
3	Particip connec	tedness	e expecte , planarit	d to get a the y, colourabili tain the skills	ty, exti	remal	graph theor	y, Ramse	, y theor	y, and g	graph

4	Requirements for Participation
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a
	small number of potential participants. In this case, the exam can be taken in the form of an oral
	exam. The decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking
	the exam.
6	Requirements on the Award of Credit Points
	Bestehen der Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
9	Literature
9	Diestel: Graph Theory, Springer Verlag
	Bollobas: Modern Graph Theory, Springer Verlag
	Mohar, Thomassen: Graphs on Surfaces, Johns-Hopkins-University Press
10	Comment
1	

Mo	dule nan	ne									
Geometry (for Teaching Degrees)											
Мо	Module no. Credit Points Workload			Se	elf-study	Duration	Frequer	су			
04-1	-10-0596 6 CP 180 h) h	180 h	1 Semester	Every 2.	semester				
	guage of man	Instruction			Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger						
1	Course	s of the Module									
	Course	no. Course	name		Workload ((•	m of ching	Contact Hours			

					per Week
	04-10-0596-vu	Geometry (for Teaching Degrees)	0	Lecture and Exercise	0
2		ometrie: Geraden, Dreiecke; Kur netrie; Konstruktionen in DGS u			ische oder
3	Methoden und	mes en kennen und verstehen die ele können diese auf typische Frage n mit einer DGS bearbeiten.	-	-	
4	•	f or Participation ra (für LaB) und Analysis 1 (für La	aB). Teilnahme c	ohne Nachweis möglig	ch.
5	 Modul Fachprüfung: Ir gegebenenfalls Teilnehmerzahl Studienleistung Abweichungen 	kamination: e Examination (Study Examination e Examination (Technical Examin der Regel erfolgt die Prüfung d mündlich. Die Form der Prüfung in den ersten beiden Veranstalt : In der Regel erfolgreiche Teilna werden in der ersten Vorlesung	nation, oral / wr urch eine Klausu g wird anhand d tungswochen fe ahme am Übung	ritten Examination, St ur, bei geringer Teilne er voraussichtlichen stgelegt. gsbetrieg. Eventuelle	
6	-	on the Award of Credit Points achprüfung; Bestehen der Studie	enleistung als Zu	ulassungsvoraussetzu	ng zur
7		e Examination (Study Examination) e Examination (Technical Examin	•		
8	Usability of the Lehramt	Module			
9		iedrich: Elementargeometrie, Sp Aodern geometry with applicati	-	994	

				nerical Analysis (fo			-			
-	dule no.	Credit F		Workload		f-study Duration Frequen			-	
	10-0597		5 CP	150 h	150 h 1 Semester Every 2. semester					
	guage of	Instruct	ion			on responsib			ıle	
	rman				Prof.	Dr. rer. nat.	Jens Lan	5		
1	Course	s of the I	Module					1		
	Course no.		Course	ourse name		Workload (CP)		Teaching I		Contact Hours per Week
	04-10-0597-vu Introduction to Numerical A (for Teaching Degrees)				alysis	0		Lecture Exercis		0
error analysis interpolation differentiation quadrature linear systems of equations and approximation non linear equations										
	and ap	proxima	tion	ons						
3	and ap non line Learnin Die Stu erkläre	proxima ear equa g Outco dierende n, impler	tion tions mes en könne	n die grundlegende n und anwenden. S						
3	and ap non line Learnin Die Stu erkläre und kor	proxima ear equa g Outco dierende n, impler mbiniere ements f	tion tions mes en könne mentiere en könne	n die grundlegende n und anwenden. S n.	ie soll	len die Meth	oden ver	gleiche		
	and ap non line Learnin Die Stu erkläre und kon Require empfor	proxima ear equa g Outco dierende n, impler mbiniere ements f ilen: Ana f Examin odule Ex	tion tions mes en könne nentiere n könne for Partic alysis und hation caminatic	n die grundlegende n und anwenden. S n. Sipation d Lineare Algebra, E	inführ	en die Meth	oden ver	gleiche	n, mod	ifizieren

	Fachprüfung: In der Regel erfolgt die Prüfung durch eine Klausur, bei geringer Teilnehmerzahl gegebenenfalls mündlich. Die Form der Prüfung wird anhand der voraussichtlichen									
	Teilnehmerzahl in den ersten beiden Veranstaltungswochen festgelegt.									
	Studienleistung: In der Regel erfolgreiche Bearbeitung eines Teils der Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.									
6	Requirements on the Award of Credit Points									
	Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung									
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 									
8	Usability of the Module M.Ed., LaG (2017) im Ergänzungsbereich, LaG (2012) Ergänzung und Kombi									
9	Literature Deuflhard, Hohmann: Numerische Mathematik I, de Gruyter, 2008 Schwarz, Köckler: Numerische Mathematik; Vieweg und Teubner, 2009 Matlab User Guide									
10	Comment									

Мо	dule nam	ne									
	Math	nematic	s of Ma	chine Learr	ning						
Module no. Credit Points Workload						Self-	study	Duratior	า	Frequency	
04-	10-0598 4 CP 120		120 h		120 h	1 Semes	ter	Every 2. semeste			
Lan	guage of	Instruct	ion			Pers	on responsik	ole for the	Modu	ule	
Ger	rman					Prof. Dr. rer. nat. Jan Giesselmann					
1	Course	s of the I	Module								
	Course	no.	Course	name			Workload (CP)	Form Teach	•••	Contact Hours per

					Week					
	04-10-0598-vu	Mathematics of Machine Learning	0	Lecture and Exercise	0					
2	Study Content Systems of linear equations and linear least squares problems, linear regression, eigenvalue and singular value decomposition, mean component analysis, Bayes stastistics, ridge regression, dimension reduction, low rank approximation, nonlinear least squares and minimization problems, Newton method, nonlinear regression, LASSO, regularization, interpolation and numerical integration, function approximation, radial basis functions, Monte-Carlo methods, networks for regression, convolutional neural networks, training of networks, deep learning									
3	 Learning Outcomes On successful completion of this module, students should be able to: 1. Explain fundamental conceptions and concerns of data analysis and machine learning, 2. Describe and apply fundamental algorithms to analyze data and to explain their relations in content and logic, 3. Implement the most important computational methods by means of typical applications and assess their importance and reliability, 4. Obtain advanced mathematical knowledge in their future academic studies and jobs via self-study 									
4	•	or Participation								
5	Form of Examin Final Module Ex • Module		ation, Written Exam, D	ouration 45 min,	, Standard)					
6	Requirements d Bestehen der Pr	on the Award of Credit Points rüfungsleistung								
7	 Grading Final Module Examination: Module Examination (Technical Examination, Written Exam, Weight: 100%, Standard) 									
8	Usability of the Bachelor MB co									
9	Literature Ethem Alpaydin: Maschinelles Lernen, de Gruyter Studium, 2019; Gilbert Srang: Linear Algebra and Learning from Data, Wellesley Cambridge Press, 2019; Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2008									
10	Comment									

Mod	lule nam	ie								
	Lie-G	roups								
Mod	lule no.	Credit P	oints	Workload	Self-study Dura			tion Frequency		
04-1	0-0599		5 CP	150 h		105 h	1 Semes	ter	Irregula	r
Lang	uage of	Instruct	ion		Pers	on responsib	le for the	Modu	ıle	
Gerr	nan and	English			Prof	. Dr. rer. nat.	Nils Sche	ithaue	r	
1	Courses	s of the l	Module							- <u>-</u>
Course no. C		Course	se name		Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-10-0382-vu Lie groups			os		0		Lecture Exercis		3
2 3	algebra Learnin	ntial Calo	group, L mes	submanifolds, Lie gi ie functor, Lie group dule	•		-	up'', m	atrix gro	oups, Lie
	•	student morphis have be matrix g have ga	s are far sm, Lie f come fa groups a ined a fi	niliar with the basic unctor, adjoint repr miliar with some im nd are able to hand rst insight into the t v to study such using	esent iporta le the heory	ation, and Lie ant concrete m / (finite dime	e group e	xponer of rea	ntial fund	nplex
4	Recom		Algebra	c ipation (elementary Group ology is helpful but						
5		f Examin odule Ex Module	aminati	on: nation (Technical Exa	amina	ation, oral / w	vritten Exa	aminat	ion, Sta	ndard)

	Fachprüfung: Usually the exam is taken in form of an oral exam (30 min), except when there are bigger number of potential participants. In this case, the exam can be taken in a written exam (90 min). The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M.ScMath: Vertiefungsbereich
	M.ScMath: Ergänzungsbereich
9	Literature
	Skript,
	J. Hilgert, K.H. Neeb: Lie-Gruppen und Lie-Algebren, Vieweg (1991)
10	Comment

Мос	dule nam	ne								
	Selec	ted To	pics in L	ogic						
Мос	dule no.	Credit	Points	Workload	Self-	-study Duratio		า	Freque	ency
04-10-0600 9 CP 270			180 h	1 Semester		Irregu	ar			
Lang	guage of	Instruc	tion		Pers	on responsib	le for the	Modu	ule	
German and English						Dr. rer. nat.	Martin O	tto		
-	Courses of the Module									
	Course no. Course name					Workload ((CP)	Form Teach		Contact Hours per Week
	04-10-0	600-vu	Selected	Topics in Logic	0			Lecture and 6 Exercise		6
2	Study C selected		in logic							

Learning Outcomes
Students understand and are able to apply the notions, methods and results treated in the
course. They have developed an advanced level of understanding of a specific topic in logic.
They are able to extend their knowledge in this field, which allows them to conduct related
research under supervision.
Requirements for Participation
recommended: depending on topic
Form of Examination
Final Module Examination:
• Module Examination (Technical Examination, oral / written Examination, Standard)
Fachprüfung: Usually the exam is taken in form of an oral exam (30 min), except when there are
bigger number of potential participants. In this case, the exam can be taken in a written exam
(90 min). The decision about the form of the exam is taken and communicated during the first
two weeks of the lecture, based on the prospective number of students taking the exam.
Requirements on the Award of Credit Points
Passing the Fachprüfung
Grading
Final Module Examination:
• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
Usability of the Module
B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
Literature
depending on topic
Comment
recommended: Mathematics: Master (log)
-

Module nam	Module name										
Selected Topics in Stochastics											
Module no.	Credit Points	Workload		Self-study	Duration	Frequency					
04-10-0601	9 CP		270 h	270 h	1 Semester	Irregular					
Language of	Instruction			Person responsible for the Module							
German and	English			Prof. Dr. rer. nat. Frank Aurzada							

	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week							
	04-10-0601-vu	Selected Topics in Stochatics	0	Lecture and Exercise	0							
2	 random graph Malliavin calc Levy processe 	Study Content various possible directions, for example - random graphs and geometric models in probability - Malliavin calculus and stochastic analysis - Levy processes - selected topis in mathematical statistic										
3		omes re knowledge in the respecti er material in a guided fashi										
4	Requirements for Participation recommended: depends on topic, but at minimum probability theory											
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated by the instructor during the first two weeks of the lecture, based on the prospective number of students taking the exam. 											
6	Requirements Passing the Fac	on the Award of Credit Poin	its									
7	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)											
8	Usability of the M.Sc. Mathema	e Module atik, M.Sc. Mathematics										
9	Literature											

Mo	dule nan									
Mo	dule no.			y Theory Workload	Self-s	Self-study Duration			n Frequency	
04-2	10-0602		4 CP	120 h		•	1 Semes	ter	-	2. semester
Lan	guage of	Instruct	ion		Perso	n responsib	le for the	e Modu	ıle	
Ger	man				Prof. I	Dr. rer. nat.	Stefan U	lbrich		
1	Course	s of the	Module							
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0602-vu Statistics/Probability Theory				C)		Lecture Exercis		3
	multiva	riate Ve	rteilunge	tik und Wahrschein n, Schätzverfahren Ingsannahme, robu	und Ko	onfidenzinte	-	١,		
3	Fähigke			swertungen vorzun ihren.	iehmer	n, grundlege	nde Schä	itzverfa	ahren u	nd
4	-		or Partic Ind Math	ipation nematik 2 (empfohle	en)					
5			aminatio	on: ation (Technical Exa	aminat	ion, Writter	n Exam, D	ouratio	n 90 mi	n, Standard)
6	Require	ements o	on the Av	ward of Credit Poin	its					
7	Grading Final M	odule Ex	kaminatio e Examin	on: ation (Technical Exa	aminat	ion, Writter	ı Exam, V	Veight:	100%,	Standard)
8	Usabili	ty of the	Module							

9	Literature
	Von Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch für Ingenieure II, Teubner Verlag Stuttgart
10	Comment

Mo	dule nam	ne									
	Scien	tific Co	mputing	g (EE)							
Мо	dule no.	Credit F	Points	Workload		Self-stu	dy	Duratio	n	Freque	ency
04-1	LO-0603		4 CP		120 h		75 h	1 Semes	ster	Every	2. semester
	guage of man	Instruct	ion				•	ble for th Stefan U		ule	
1	Course	s of the I	Module								
	Course no.		Course	name		Wa	orkload (CP)	Form Teacł	•••	Contact Hours per Week
	04-10-0	04-10-0603-vu Scientific Computing 0					Lecture and 3 Exercise		3		
	Numeri	sche Qu	adraturv	arer Gleichur erfahren, Nic ntialgleichun	chtline	are Gleich	nungssyst	teme, An	•	•	llem
3	Fähigke	-		nde Aufgaber venden.	nstellur	igen geei	gnete nu	merische	Verfał	nren	
4	Require	ements f	or Partio	cipation							
5	Form of Examination Final Module Examination:										
	•	Module	e Examin	ation (Techn	ical Exa	aminatior	n, Writte	n Exam, D	Ouratio	n 90 mi	n, Standard)
6	Require	ements o	on the A	ward of Cred	lit Poin	ts					

7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, Written Exam, Weight: 100%, Standard)
8	Usability of the Module
	Für B.Sc.ETIT, B.Sc.MEC, B.Sc.CE, B.Sc.Inf,
9	Literature
	Von Finckenstein, Lehn, Schellhaas, Wegmann: Arbeitsbuch für Ingenieure II, Teubner Verlag Stuttgart
10	Comment
10	

Мос	dule nam	ie								
				: Mathematics in			[
		Workload	Workload Self-s		Duratio	-	Frequ	•		
04-1	0-0604		6 CP	180 h		135 h	1 Semes	ter	Every	2. semester
Language of Instruction						son responsib	le for the	e Modu	le	
Geri	man				Prof	. Dr. phil. nat	. Katja Kr	üger		
1	Courses	s of the	Module							
Course no		no.	Course	name	Workload (CP)		Teaching Hou per		Contact Hours per Week	
			Practical mathem	l training in schools II for natics		0		Seminar		2
	04-10-0	504-se	Consulta	tion and reflection		0		Seminar		1
2	Study Content Beobachtung, Planung und Reflexion von Mathematikunterricht sowie didaktischer und methodischer Konzepte der Unterrichtsgestaltung unter Einbindung fachdidaktischer Literatur; tiefgreifende Auseinandersetzung mit einem fachdidaktischen Schwerpunkt. Die Studierenden führen ihr Portfolio aus den Praxisphasen I und II während der Praktikumszeit fort, nehmen an einem für berufliche Schulen spezifischen Beratungsangebot teil und verfassen einen Praktikumsbericht.									
3	Learning Outcomes Die Studierenden sind in der Lage, kriterienbasiert Unterricht zu beobachten, zu analysieren und zu planen und die eigene Durchführung entsprechend zu reflektieren. Sie können auf der									

se verfassen. Frements for Participation dlagen des Lehrens und Lernens von Mathematik, Praxisphase I (Teilnahme ohne Nachweis ch) of Examination Module Examination: Module Examination (Technical Examination, Portfolio, Standard)
dlagen des Lehrens und Lernens von Mathematik, Praxisphase I (Teilnahme ohne Nachweis ch) of Examination Module Examination:
ch) of Examination Module Examination:
Module Examination:
Module Examination (Technical Examination, Portfolio, Standard)
Module Examination (Study Examination, Special Form, Standard)
rüfung: Sonderform (benoteter Praktikumsbericht)
enleistung: Sonderform (Hausübungen, Unterrichtsbesuch mit Reflexion, Fortführung des
blios aus den Praxisphasen I und II, Teilnahme an einem Beratungsangebot)
rements on the Award of Credit Points
ng Module Examination:
Module Examination (Technical Examination, Portfolio, Weight: 100%, Standard)
Module Examination (Study Examination, Special Form, Weight: 0%, Standard)
lity of the Module
ture
1

Мос	Module name										
Selected Topics in Analysis											
Мос	lule no.	Credit Points	Workload		Self-study	Duration	Frequency				
04-10-0605		9 CP		270 h	180 h	1 Semester	Irregular				
Lang	guage of	Instruction			Person responsib	le for the Modu	ıle				
Gerr	German and English Prof. Dr. rer. nat. Matthias Hieber										
1	1 Courses of the Module										

	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week				
	04-10-0605-vu	Selected Topics in Analysis	0	Lecture and Exercise	6				
2	Study Content depending on topic, examples include: - conservation equations - stochastic PDEs - geo-physical flows - free boundary value problems - chemotaxis - Besov spaces - pseudo differential operators								
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of a specific topic in analysis - are able to extend their knowledge in this field - are able perform supervised research in this field								
4	Requirements for Participation recommended: depending on topic, typically Functional Analysis								
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 								
6	Requirements on the Award of Credit Points Passing the Fachprüfung								
7	Grading Final Module Ex Modul Standar	e Examination (Technical Exar	nination, oral / written	Examination, W	eight: 100%,				
8	Usability of the	Module							

	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (ana)

	Seleo	ted Tor	oics in Lo	ogic								
Mo	dule no.	_		Workload	Self-study Duration		n Frequency		ncy			
04-10-0606 5 CP 150					105 h	105 h 1 Semes						
Lan	guage of	Instruct	ion		Person responsit	le for the	Modu	ıle				
Ger	rman and	English			Prof. Dr. phil. nat	. Ulrich Ko	bhlenb	ach				
1	Course	Courses of the Module										
	Course no. Cour			name	Workload (Workload (CP)		of ning	Contact Hours per Week			
	04-10-0606-vu Selec			Topics in Logic	0	0		Lecture and Exercise				
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of a specific topic in computational logic - are able to extend their knowledge in this field											
	- are able perform supervised research in this field											
	Requirements for Participation											
4	Require	ements f	or Partic	ipation								
	Form o	f Examir	ation									
	Form o	f Examir										
4	Form o	f Examir odule Ex	a tion caminatio		amination, oral / v	vritten Exa	aminat	ion, Sta	ndard)			

	exam. The decision about the form of the exam is taken and communicated during the first two
	weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on the topic
10	Comment recommended: Mathematics: Master (log)

	Disco	ontinuo	us Gale	rkin Methods (9 C	P)						
Module no. Credit Points Workload					Self-study Duration			n Frequenc		ency	
04-10-0607 9 CP 270 h					180 h 1 Semes			ter Irregular			
Language of Instruction					Person responsible for the Module						
Ger	rman				Prof.	Dr. rer. nat.	Jan Giess	elman	n		
1	Courses of the Module										
	Course no. Course		e name		Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-10-0607-vu Disconti CP)		nous Galerkin Methods (9		0		Lecture and Exercise		6		
2	Study Content										
	Theory of Discontinuous Galerkin methods for linear elliptic parabolic and hyperbolic PDEs; stability and consistency, a-priori and a-posteriori error estimates, interior penalty, upwinding; implementation of practical problems in e.g. matlabTheory of Discontinuous Galerkin methods for linear elliptic parabolic and hyperbolic PDEs; stability and consistency, a-priori and a- posteriori error estimates, interior penalty, upwinding; implementation of practical problems in e.g. matlab										

3	Learning Outcomes
3	Students know paradigms for constructing Discontinuous Galerkin discretisations for certain
	problem classes (linear elliptic, parabolic and hyperbolic first and second order PDEs) and can
	devise, analyse and implement discretisations of these problems
4	Requirements for Participation
	recommended: Numerical methods for ordinary differential equations, numerical methods for
	partial differential equations
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Duration 90
	min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a
	small number of potential participants. In this case, the exam can be taken in the form of an oral
	exam. The decision about the form of the exam is taken and communicated during the first two
	weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, eral (written Examination, Weight: 100%)
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	M. Sc. Mathematik, M. Sc. Mathematics
9	Literature
	D. A. Di Pietro, A. Ern: Mathematical Aspects of Discontinuous Galerkin Methods (Book,
	Springer) B. Riviere: Discontinuous Galerkin Methods for Solving Elliptic and Parabolic Equations (Book, SIAM)
10	Comment

Module nam	Module name										
PDE	II. Evolution Eq	uations									
Module no.	Credit Points	Workload	Self-study	Duration	Frequency						

04-1	.0-0608		9 CP	270 h		180 h	1 Semes	ter	Irregula	ar	
Lang	guage of	Instructi	ion		Person responsible for the Module						
Gerr	man and	English			Prof	. Dr. rer. nat.	Dieter Bo	othe			
1	Courses	s of the N	Module								
	Course no. Course name					Workload (C		Form Teacl	•••	Contact Hours per Week	
	04-10-0	04-10-0608-vu PDE II. Evolution Equations				0	Lecture and Exercise		6		
2	Study Content operator semigroups, characterization of semigroup generators due to Hille-Yoshida, dissipative operators and characterization of semigroup generators due to Lumer-Philipps, conservative operators and regularity of operator semigroups										
3	Learning Outcomes The students know and understand the mathematical concepts, methods and results mentioned under the list of learning content, and are able to apply those. They have a deeper understanding of abstract evolution equations. They are able to expand their knowledge in this area independently and to tackle research questions in this field under guidance.										
4	-		or Participat Funktionala								
5		f Examin odule Ex	ation amination:								
	•	Module min, Sta		n (Technical Ex	amina	ation, oral / w	vritten Exa	amina	tion, Du	ration 90	
	small n exam. T	umber of The decis	f potential pa ion about th	am is taken in f articipants. In t le form of the e on the prospec	his ca xam i	se, the exam s taken and c	can be ta communic	ken in ated o	the form during th	m of an oral	
6	-		on the Award	d of Credit Poin	its						
7	Grading Final M	odule Ex		n (Technical Ex	amina	ation, oral / v	vritten Exa	amina	tion, We	eight: 100%,	
8	Usabilit	ty of the	Module								

9	Literature
	Engel, Nagel: One-parameter semigroups for linear evolution equations, Springer, New York, 2000. Pazy: Semigroups of linear operators and applications to partial differential equations, Springer
10	Comment

Mo	dule nam	-		wo mo on otion						
	dule no.		oints	tromagnetics Workload	Self	-study	Duratio		Freque	•
	LO-0611		5 CP	150 h	_		1 Semes		Irregula	r
Language of Instruction German and English						on responsib Dr. Kersten Sc		e Modu	ule	
1 1	1	0	Madula		PDL		mmut			
-				e se name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	00611-vu Computational Electromagnetics 0					Lecture and 3 Exercise		3	
	current	model,	Maxwell	s in electromagnetic equations), variatic zation and Numeric	onal f	ormulation ir			•	•
3	Learnin Student	g Outco ts	mes							
	- under	stand an	d are ab	le to apply the notio	ons, r	nethods and	results tr	eated i	in the co	urse
		•		evel of understandin liscretizations	ng of	the solution	theory fo	r elect	romagne	tic
	- are ab	le to ext	end thei	r knowledge in this	field					
	- are ab	le perfo	rm super	vised research in th	is fie	ld				

4	Requirements for Participation
-	Grundlagen in Numerik, Grundkenntnisse partieller Differentialgleichungen
	or undragen in Numerik, or undkenntnisse partiener Direrentialgielenungen
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
6	Requirements on the Award of Credit Points
7	Grading
1	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M.Sc.Mathematik, M.Sc.Mathematics, M.Sc.CE, M.Sc.ETIT, M.Sc.Mechanik, M.Sc.Phys.
9	Literature
	Monk, Finite Element Methods for Maxwell's Equations, Oxford Scientific Publications
	Alonso-Rodriguez, Valli, Eddy Current Approximation of Maxwell Equations: Theory, Algorithms
	and Applications, Springer,
	Braess, Finite Elements, Springer
10	Comment

Mo	dule nan	ne									
	Intro	duction	to Nun	nerical Analy	ysis ar	nd Die	dactics of A	nalysis			
Module no. Credit Points Workload						Self-	study	Duratio	n	Frequency	
04-10-0612 8 CP			240 h		210 h 1 Semester			Every 2. semester			
Language of Instruction German						Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger					
1	Course	s of the no.	Course	name			Workload ((CP)	Form Teach	•.	Contact Hours per Week
	04-00-0	159-se	Seminar	for subject-spe	ecific		0		Semina	ar	2

					. 1				
		didactics: Analysis in schools							
	04-10-0597-vu	Introduction to Numerical Analysis (for Teaching Degrees)	0	Lecture and Exercise	0				
2	lineare Ausglei Funktionsprop Grenzwertbeg in der Schule, I	Interpolation, Differentiation, Qu chsrechnung, nichtlineare Gleichu ädeutik, Funktionsuntersuchunge riff, Riemannscher Integralbegriff, Fehlvorstellungen von Schüer*inne taltung, Technologieeinsatz	ingen. n, Lokale Änderungsra Anwendungen der Int	ate und finitesimalrech					
3			numerischen Verfahr	en beschreibe	n, erklären				
		n die Methoden vergleichen, mod en fachliche Sicherheit in besonde			alysis und				
	• könne	n verschiedene Zugänge und Schw	verpunktsetzungen ge	geneinander a	bwägen.				
	• beherrschen Darstellungen und Konzepte, um Themengebiete der Analysis in der Schule zu veranschaulichen - auch mit Technologieeinsatz								
	 praktiz Förder 	tieren in den Übungen zahlreiche I rung.	Beispiele für intelligen	ites Üben, Dia	gnose und				
4	Analysis, Linea	for Participation re Algebra, Grundlagen des Lehre ne Nachweis möglich)	ns und Lernens von M	athematik					
5	Form of Exami Final Module E								
	• Modu	le Examination (Study Examinatio	n, Homework, Worksh	neets, Standar	·d)				
	• Modu	le Examination (Technical Examina	ation, Special Form, D	uration 45 mir	n, Standard)				
	Studienleistun Teils der Hausi Studienleistun bekannt gegeb erfolgreiche Be Die Kriterien d	Sonderform (Mündliche Prüfung m g: Sonderform (In der Vorlesung ir übungen. Die Anzahl sowie das Be g wird während des ersten Verans een. Im Seminar in der Regel aktive earbeitung von Lernaufträgen wie iesbezüglich werden während des rüfer bekannt gegeben.)	n der Regel eine erfolg wertungsschema der l staltungstermins durch e Mitarbeit in den Sem z.B. Hausübungen ode	Hausübungen n die Prüferin/ ninarsitzungen er ein Semeste	als den Prüfer und erprodukt.				

-										
6	Requirements on the Award of Credit Points									
	Bestehen der Fachprüfung;									
	Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung									
	Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung [/04-00-0159-se fachdidaktisches									
	seminar: analysis in der schule].									
	Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende									
	Diskussionen und Reflexionen z.B. von Erfahrungen mit Unterrichtsmethoden und -materialien									
	sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die									
	Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene									
	Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden									
	Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.									
-										
7	Grading									
	Final Module Examination:									
	Module Examination (Study Examination, Homework, Worksheets, Weight: 0%,									
	Standard)									
	 Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) 									
	• Module Examination (reclinical Examination, Special Form, Weight: 100%, Standard)									
8	Usability of the Module									
	Mathematik: Lehramt									
9	Literature									
	Deuflhard, Hohmann: Numerische Mathematik I, de Gruyter, 2008									
	Schwarz, Köckler: Numerische Mathematik; Vieweg und Teubner, 2009									
	Büchter, A., Henn, HW.: Elementare Analysis: Von der Anschauung zur Theorie. Spektrum									
	2010.									
	Greefrath, G., Oldenburg, R., Siller, H. S., Ulm, V., und Weigand, H. G. Didaktik der Analysis.									
	Wiesbaden: Springer-Verlag 2016									
	Schunnar, B. und Humanhargar, H. Elamantara Numarik für die Sakundarstufe, Springer 2015									
	Schuppar, B, und Humenberger, H: Elementare Numerik für die Sekundarstufe. Springer 2015.									
	Tietze, UP., Klika,M., Wolpers, HH.: Mathematikunterricht in der SII, Bd. 1,									
	Fachdidaktische Grundfragen, Didaktik der Analysis. Vieweg 2000,									
	Gängige Schulbücher									
10	Comment									

			-	pecific didactics:				_		
Module no. Credit Points Workload 04-10-0613 3 CP 90 H					Self-study	Duration		Freque	-	
				90 h		1 Semest			2. semester	
	i guage of rman	Instruct	lon		Person responsil Prof. Dr. phil. nat			lle		
1		s of the	Modulo				JECI			
-	Course		Course	name	Workload (Workload (CP)		of iing	Contact Hours per Week	
	04-00-0	043-pj	-	or subject-specific : Problem solving	0		Project	:	4	
2	lernen - Überb - Lösen - Anfor Reflexio	f und ve lick übe von Pro derunge on entsp	r einschla blemauf n an unto rechend	ne Vorstellungen in ägige Forschungserg gaben und Reflexion errichtsgeeignete Pr er Aufgaben	gebnisse mit Unte n von Heuristiken	rrichtsbez	ug			
3	Learning Outcomes - Entwicklung von Handlungskompetenz zur Planung von Mathematikunterricht, in dem mathematische Problemlösungskompetenz erworben werden kann - Erarbeitung und eigene Erprobung eines Konzeptes zum Problemlösen lernen, z.B. eines Knobelwettbewerbs, einer Heurismenschulung o.ä. - Gewinnen und Reflektieren eigener Problemlöseerfahrung und von Handlungswissen über Heurismen									
	Heurisr	nen								
4	Require Grundla	ements f agen des		cipation 5 und Lernens von M 7eis möglich)	lathematik, Praxis	semester				
4	Require Grundla (Teilnal	ements f agen des nme ohn f Examir	E Lehrens Ie Nachw	s und Lernens von N veis möglich)	1athematik, Praxis	semester				

	Fachprüfung: Hausarbeit
	Studienleistung: Sonderform (in der Regel erfolgreiche Teilnahme an den
	Projektveranstaltungen und Führen eines Portfolios)
6	Requirements on the Award of Credit Points
	Bestehen der Fachprüfung, Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Study Examination, Portfolio, Weight: 0%, Passed / Not Passed)
	 Module Examination (Technical Examination, Homework Assignment, Weight: 100%, Standard)
8	Usability of the Module
	Mathematik: Lehramt
9	Literature
10	Comment

Мос	dule nam	ne								
	Proje	ect for s	ubject-s	pecific didactics:	Appli	cation-orie	nted ma	thema	atical les	ssons
Мос	dule no.	Credit I	Points	Workload	Self-	study	Duration Frequency			
04-1	04-10-0614 3 CP 90 H					30 h	1 Semes	ter	Every 2	. semester
Language of InstructionPerson responsible for the ModuleGermanProf. Dr. phil. nat. Katja Krüger										
1	Courses of the Module									
	Course no. Course name					Workload (CP)	Form Teacł		Contact Hours per Week
	04-00-0	113-pj	didactics	or subject-specific :: Application-oriented atical lessons	ł	0		Project	t	4
2	Study C	Content	•							·
	Begriff	und vers	schieden	e Konzeptionen eine	es anv	wendungsori	entierten	Mathe	ematikur	nterrichts;

	deskriptives und normatives Modellieren, Anforderungen an Modellierungsaufgaben und eigene Begutachtungen oder Konstruktionen solcher Aufgaben; Vertiefte Betrachtung der Kompetenz des mathematischen Modellierens: eigene Modellierungserfahrungen und entsprechende Reflexion oder Betreuung der Modellierungswoche mit Schüler*innen
3	Learning Outcomes
4	Requirements for Participation Grundlagen des Lehrens und Lernens von Mathematik, Praxissemester (Teilnahme ohne Nachweis möglich)
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Portfolio, Passed / Not Passed)
	Module Examination (Technical Examination, Homework Assignment, Standard) Fachprüfung: Hausarbeit Studionleistung: Sandarform (in der Dagel arfelgreiche Teilnehme en den
	Studienleistung: Sonderform (in der Regel erfolgreiche Teilnahme an den Projektveranstaltungen und Führen eines Portfolios)
6	Requirements on the Award of Credit Points Bestehen der Fachprüfung, Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung
7	 Grading Final Module Examination: Module Examination (Study Examination, Portfolio, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Homework Assignment, Weight: 100%, Standard)
8	Usability of the Module Mathematik: Lehramt
9	Literature ISTRON-Materialien Bd. 1 - 14 Greefrath, G. (2018). Anwendungen und Modellieren im Mathematikunterricht. Berlin, Heidelberg: Springer Berlin Heidelberg.
	Hinrichs, G. (2008). Modellierung im Mathematikunterricht. Spektrum, Akad. Verlag.

	Maaß, K. (2007). Mathematisches Modellieren: Aufgaben für die Sekundarstufe I. Cornelsen Scriptor.
	Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer.
10	Comment

Мо	dule nam	ne							
	Proje	ct for s	ubject-s	pecific didactics:	Online Task Trai	ning			
Module no. C		Credit I	Points	Workload	Self-study	Duration		Freque	ncy
04-	10-0615		3 CP	90 h	60 h	1 Semeste	er	Every 2	. semester
Language of Instruction German				Person responsik Prof. Dr. phil. nat			le		
1	Course	s of the	Module		-		_		
	Course	no.	Course	name	Workload (,	Form (Teachi	-	Contact Hours per Week
	04-10-0	615-pj	-	or subject-specific : Online Task Training	0 g		Project Semina	r	2
	Wirtsch	aftsmat	hematik	Auswahl aus Teilmo , Optimierung, Grap ische Simulation					dgesetz,
3		g Outco dierende	mes en erwer	ben					
	Lösung: -Handlu Mather	swegen Ingswiss natik.	aus verso en zur Tl	on Mathematikaufg chiedenen schulrele neorie des Arbeiten en Lernumgebunge	vanten Themenfe s mit Aufgaben be	ldern; im Lehren			on
		-	-	altung guter Erkläru			t erste	ellten Le	rnsequenz
4	Grundla	agen des		cipation a und Lernens von N veis möglich)	1athematik, Praxis	semester			

5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, Homework Assignment, Standard)
	Module Examination (Study Examination, Portfolio, Passed / Not Passed)
	Fachprüfung: Hausarbeit
	Studienleistung: Sonderform (in der Regel erfolgreiche Teilnahme an den Projektveranstaltungen und Führen eines Portfolios)
6	Requirements on the Award of Credit Points Bestehen der Fachprüfung, Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, Homework Assignment, Weight: 100%, Standard)
	• Module Examination (Study Examination, Portfolio, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematik: Lehramt
9	Literature Wagner, A. amp; Wörn, C. (2011). Erklären lernen - Mathematik verstehen. Ein Praxisbuch mit Lernangeboten. Seelze: Klett Kallmeyer.
	Kiel, E.; Meyer, M.; Müller-Hill, E. (2015): Erklären. Was? Wie? Warum? - In: PM : Praxis der Mathematik in der Schule, 57 (2015) 64, 2-9.
	MOODLE-Kurs online mit Skript
10	Comment

Module name							
Math	nematical Statis	tics					
Module no.	Credit Points	Workload	Self-study		Duration	Frequency	
04-10- 0616/en	9 CP	27(0 h		1 Semester	Every 3. semester	

	guage of Instruc	tion	Person responsit Prof. Dr. rer. nat.	ble for the Module Michael Kohler				
1	Courses of the	Module						
	Course no.	Course name	Workload (CP) Form of Teaching	Contact Hours per Week			
	04-10-0616-vu	Mathematical Statistics	0	Lecture and Exercise	6			
2	Study Content Estimation of o VC theory, density estimate point estimates statistical tests confidence inter Possible societ	tion, s,	ressed in the lecture.					
3	Learning Outcomes The students know and understand the above mentioned concepts, methods and results, and are able to apply them. They have a deep unterstanding of Mathematical Statistics and are able to learn new knowledge in this field by themselves. Students are able to contextualize subject matter within the social context, critically assess the consequences, and act ethically and responsibly accordingly.							
4	-	for Participation : Probability theory						
5			Examination, oral / v	vritten Examination, D	Ouration 90			
	of potential pa decision about	im is taken in form of a wr rticipants. In this case, the the form of the exam is ta two weeks of the lecture,	e exam can be taken i aken and communica	in the form of an oral ited	exam. The			
6	Requirements Passing the Fac	on the Award of Credit Po chprüfung;	pints					
7	Grading Final Module E	xamination.						

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	M. Sc. Mathematics, Mathematics in Data Science
9	Literature
	Lehmann, Romano: Testing Statistical Hypotheses.
	Devroye, Lugosi: Combinatorial methods in density estimation
10	Comment

Мос	dule nan	ne								
	Stati	stical th	eory fo	r Deep Learning	1				1	
04-1	dule no. 10- 7/en	Credit Points 9 CP		Workload 270 h	,		Duration 1 Semester		Frequency Every 3. semeste	
Language of Instruction					on responsib . Dr. rer. nat.					
1	Course	s of the	Module							
	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	617-vu	Statistica Learning	al theory for Deep		0		Lecture and Exercise		6
2	Study Contenttypes of neural networks,nonparametric regression and image classification,gradient descent,approximation results for feed forward neural networks,rate of convergence for least squares neural network estimates,analysis of neural networks learned by gradient descentPossible societal implications will be addressed in the lecture									
3	The stu are able	e to appl	now and y them.	understand the ab They have a deep u hthis field by thems	nters	tanding of De				

	Students are able to contextualize subject matter within the social context, critically assess the
	consequences, and act ethically and responsibly accordingly.
4	Requirements for Participation
	recommended: Probability theory
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Usually the exam is taken in form of a written test, except when there are only a small number
	of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking
	the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung;
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	M. Sc. Mathematics, Mathematics in Data Science
	B. Sc. Electives
9	Literature
	Goodfellow, Bengio, Courville: Deep Learning.
	Györfi, Kohler, Krzyzak, Walk: A distribution - free theory of nonparametric regression
10	Comment

Module nam	ne				
Deep	Learning Lab				
Module no.	Credit Points	Workload	Self-study	Duration	Frequency
04-10- 0618/en	5 CP	150	-	1 Semester	Irregular

	guage of Instruc	tion	Person responsible for the Module							
Eng	lish		Prof. Dr. Yann Disser							
L	Courses of the	Module								
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week					
	04-10-0618-vu	Deep Learning Lab	0	Lecture and Exercise	3					
2	convolutional r	o deep learning, mathematic neural nets, adversarial deep al implications will be addres	learning, text generat		assification,					
	Learning Outco	omes								
	The students know and understand the concepts and methods taught in the course and can apply them. They have a thorough understanding of the formal foundations of deep learning. They are able to independently expand their knowledge of the field and pursue supervised research projects. Students are able to contextualize subject matter within the social context, critically assess the consequences, and act ethically and responsibly accordingly.									
	Recommended Algorithmic Dis Einführung in d	screte Mathematics die Optimierung (Introductio	n to optimization)							
	programming e	expertise (ideally Python)								
;	Form of Examination									
	Final Module E	xamination:								
	• Modu	 Module Examination (Study Examination, Paper, Passed / Not Passed) 								
	Studienleistun	g: Presentation								
;	Requirements Passing Studier	on the Award of Credit Poir nleistung	nts							
,	Grading Final Module E	xamination:								
	• Modu	le Examination (Study Exami	nation, Paper, Weight:	100%, Passed / No	ot Passed)					
3	Usability of the	e Module								
	-	natics, Mathematics in Data S	Science. NOT as part of	an Advanced Cou	rse.					
)	Literature									
	Deep Learning	with Python (2nd edition) - I	François Chollet							

10	Comment

Мо	dule nam	ne									
	Effici	ent Me	thods fo	or Data Assimila	atic	on					
04-	dule no. 10- .9/en	Credit F	Points 5 CP	Workload 150		Self-	study 105 h	Duratio 1 Semes		Freque Irregul	-
	guage of lish	Instruct	ion				on responsib . Dr. rer. nat.				
1	Course	Courses of the Module									
	Course	no.	Course	name			Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-10-0	619-vu	Efficient Assimila	Methods for Data tion			0		Lecture and Exercise		3
	method	ds;		Iter; nudging met	LIIO	us (e	.g. Luenberge	er observ	er), m	ouerred	
3	The stu They ur used in They ca	nderstan practise in choos	now the r nd their p e. e approp	most important n roperties and nu priate data assimi these methods.	me	rical	challenges ar	ising wh	en thes	e meth	ods are
4	Recomi Differe	mended: ntialgleid	chungen	c ipation ung in die Stocha (Ordinary Differe k (Introduction to	nti	al Eq	uations), Einf	ührung i		wöhnlid	che
5		f Examir odule Ex	nation kaminatio	on:							

	Module Examination (Technical Examination, oral / written Examination, Duration 60
	min, Standard)
	Usually the exam is taken in form of a written test, except when there are only a small number
	of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	M. Sc. Mathematics, Mathemaics in Data Science
9	Literature
	Kody Law, Andrew Stuart, Konstantinos Zygalakis; Data Assimilation: A mathematical introduction, Springer, 2015
	Mark Asch, Marc Bocquet, Maelle Nodet; Data Assimilation: Methods, Algorithms and Applications, SIAM 2016
10	Comment

Мо	dule nan	ne									
	Num	erics of	PDEs w	ith Uncerta	ain Dat	а					
04-	dule no. 10- .0/en	Credit F	Points 9 CP	Workload	270 h	Self-st	•	Duration 1 Semest		Frequ e Irregu	•
	guage of lish	Instruct	ion				n responsib Dr. rer. nat.			ule	
1	Course	s of the	Module								
	Course	no.	Course	name		١	Workload ((CP)	Form Teach	•••	Contact Hours per Week

	04-10-0620-vu	Numerics of PDEs with Uncertain Data	0	Lecture and Exercise	6
2	finite element r strong formulat Monte Carlo fir Monte Carlo fir weak formulati Loeve expansion, weak solutions parabolic PDEs, elements,	ons of elliptic PDEs with uncertai	ain data, n data, stochastic Gale	erkin method,	Karhunen-
3	design principle differential equ	omes e able to describe, explain and ap es of numerical solution methods lations with deterministic as well ate, implement and compare the	for linear elliptic and as uncertain data. Th		
4	-	for Participation : Introduction to Numerical Analy ations	vsis, Numerical Metho	ds for Ordinar	у
5	min, St	xamination: e Examination (Technical Examin andard)			
	of potential par decision about	m is taken in form of a written te rticipants. In this case, the exam o the form of the exam is taken an two weeks of the lecture, based	can be taken in the for d communicated	m of an oral e	xam. The
6	Requirements Passing Fachpri	on the Award of Credit Points üfung			
7	Grading Final Module Ex Modul Standa	e Examination (Technical Examin	ation, oral / written Ex	xamination, W	'eight: 100%,

8	Usability of the Module
	M. Sc. Mathematics, Mathemaics in Data Science
9	Literature
	S. Brenner, R. Scott: Mathematical Theory of Finite Element Methods, Texts in Applied Mathematics, Vol. 15, Springer, 2008
	S. Larsson, V. Thomée: Partial Differential Equations with Numerical Methods. Texts in Applied Mathematics, Vol. 45, Springer 2003.
	G. J. Lord, C. E. Powell, and T. Shardlow. An Introduction to Computational Stochas- tic PDEs. Cambridge University Press, 2014.
10	Comment

Мо	dule nan	ne								
	Scala	ble Line	ear Solv	ers for Data Scien	ce					
04-1	dule no. LO- 1/en	Credit F	Points 5 CP	Workload 150 h		study 105 h	Duratio 1 Semes	-	Freque Irregula	•
Lan g Engl	guage of lish	Instruct	ion			on responsib . Dr. rer. nat.			ule	
1	Course	s of the	Module		•					
	Course	no.	Course	rse name		Workload (CP)		Teaching H		Contact Hours per Week
	04-10-0	621-vu	Scalable Science	Linear Solvers for Dat	a	0		Lectur Exercis		3
2										
3	Studen		e able to	describe, explain ar able linear solvers f	-		ney will b	e able	to analy	vze,

	evaluate, implement and compare the methods.
4	Requirements for Participation Recommended: Introduction to Numerical Analysis
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M. Sc. Mathematics, Mathemaics in Data Science
9	Literature Wolfgang Hackbusch, Iterative Solution of Large Sparse Systems of Equations, 2nd ed. 2016, Applied Mathematical Sciences Vol. 95, Springer International Publishing, 2016
10	Comment

Module nam	ne						
Data	Data Assimilation for Fluid Dynamics						
Module no. 04-10- 0622/en	Credit Points 5 CP	Workload	150 h	Self-study 105 h	Duration 1 Semester	Frequency Irregular	
Language of English	Instruction			Person responsible for the Module Prof. Dr. rer. nat. Moritz Egert			

1	Courses of the			Farmer of	Contact	
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week	
	04-10-0622-vu	Data Assimilation for Fluid Dynamics	0	Lecture and Exercise	3	
2		ems and control theory, feedb , asymptotic stability, referend		•		
	Classical data a interpolation.	ssimilation algorithms (Kalma	n filter, AOT), resolution	n of spatial mesh	ı, nodal	
	Fundamental e	quations in fluid dynamics, Bo	ussinesq approximatio	n.		
3	Learning Outco	o mes rstand and are able to apply th	a nations mathods an			
	course. They de	evelop an advanced level of ur ethodology of data assimilatio	nderstanding of partial	differential equa	tions	
4	course. They do through the me field. Requirements	evelop an advanced level of ur	nderstanding of partial n and are able to exten	differential equa	tions	
	course. They do through the me field. Requirements Recommended Form of Examin Final Module E	evelop an advanced level of ur ethodology of data assimilatio for Participation I: Functional Analysis, Partial D nation xamination:	nderstanding of partial n and are able to exten Differential Equations I	differential equa d their knowled	tions ge in this	
4	course. They do through the me field. Requirements Recommended Form of Examin Final Module E • Modul	evelop an advanced level of ur ethodology of data assimilatio for Participation I: Functional Analysis, Partial D nation	nderstanding of partial n and are able to exten Differential Equations I	differential equa d their knowled	tions ge in this	
	course. They do through the me field. Requirements Recommended Form of Examin Final Module E Modul min, St Usually the exa of potential pai decision about	evelop an advanced level of ur ethodology of data assimilatio for Participation I: Functional Analysis, Partial D nation xamination: le Examination (Technical Exar randard) im is taken in form of a writter rticipants. In this case, the exa the form of the exam is taken	nderstanding of partial n and are able to exten Differential Equations I n test, except when the m can be taken in the f and communicated	differential equa d their knowledg Examination, Du re are only a sma form of an oral e	uration 60 all number xam. The	
	course. They do through the me field. Requirements Recommended Form of Examin Final Module E Modul min, St Usually the exa of potential pai decision about	evelop an advanced level of ur ethodology of data assimilatio for Participation I: Functional Analysis, Partial D nation xamination: le Examination (Technical Exar randard) im is taken in form of a writter rticipants. In this case, the exa	nderstanding of partial n and are able to exten Differential Equations I n test, except when the m can be taken in the f and communicated	differential equa d their knowledg Examination, Du re are only a sma form of an oral e	uration 60 all number xam. The	
	course. They do through the me field. Requirements Recommended Form of Examin Final Module E Modul min, St Usually the exa of potential pan decision about during the first the exam.	evelop an advanced level of ur ethodology of data assimilatio for Participation I: Functional Analysis, Partial D nation xamination: le Examination (Technical Exar andard) im is taken in form of a writter rticipants. In this case, the exa the form of the exam is taken two weeks of the lecture, bas on the Award of Credit Points	n and are able to exten	differential equa d their knowledg Examination, Du re are only a sma form of an oral e	uration 60 all number xam. The	

	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M. Sc. Mathematics, Mathematics in Data Science
9	Literature M. Tucsnak, G. Weiss: Observation and Control for Operator Semigroups (Springer) TP. Tsai: Lectures on Navier-Stokes Equations (AMS) S. Reich, C. Cotter: Probabilistic Forecasting and Bayesian Data Assimilation (Cambrige University Press)
10	Comment

Мос	dule nan	ne								
	First	order n	nethods	for optimization	in da	ata analytics				
04-1	dule no. .0- 3/en	Credit F	Points 5 CP	Workload 150 h		study 150 h	Duration 1 Semes	-	Freque Irregula	-
Lang Engl		Instruct	ion			on responsib . Dr. rer. nat.			ule	
1	Course	s of the	Module							
	Course no.		Course	ourse name		Workload (CP)		Form of Teaching		Contact Hours per Week
				t-order methods for mization in data analytics		0		Lectur Exercis		0
2	2 Study Content First-order methods are a highly active research field in optimization, in particular for applications in data analytics. They often combine primal-dual decomposition approaches wit relatively simple iteration schemes and provide very efficient structure-exploiting algorithms challenging large scale problems. This course gives an introduction into the design and theory first-order proximal point and primal-dual optimization methods.						aches with orithms for			
3	The stu methoo	ds, in par	e able to rticular p	apply and investig roximal point and p and applications in	orimal	-dual method	ds. They a			

4	Requirements for Participation Recommended: Introduction to Optimization; Nonlinear Optimization
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Usually the exam is taken in form of a written test, except when there are only a small number
	of potential participants. In this case, the exam can be taken in the form of an oral exam. The
	decision about the form of the exam is taken and communicated during the first two weeks of
	the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
-	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
•	M. Sc. Mathematics, Mathematics in Data Science
9	Literature
	Stephen Boyd, Neal Parikh, Eric Chu, Borja Peleato, Jonathan Eckstein: Distributed Optimization and Statistical Learning via the Alternating Direction Method of Multipliers, Foundations and Trends in Machine Learning Vol. 3, No. 1 (2010), 1–122.
	Antonin Chambolle, Thomas Pock: A First-Order Primal-Dual Algorithm for Convex Problems with Applications to Imaging, Journal of Mathematical Imaging and Vision, Vol. 40, No. 1 (2011),
	120-145.
	Christian Clason, Tuomo Valkonen: Intoduction to Nonsmooth Analysis, arXiv:2001.00216v3, https://doi.org/10.48550/arXiv.2001.00216
10	Comment
1	

Module nam	Module name											
Optii	Optimization Methods for Maschine Learning											
Module no.	Credit Points	Workload		Self-study		Duration	Frequency					
04-10-	5 CP		150 h		105 h	1 Semester	Every 2. semester					

062	24/en										
	guage of Instruc	tion		Person responsible for the Module							
-	lish		Prof	. Dr. rer. nat. Marc	Pfetsch						
1	Courses of the	Module		I							
	Course no.	Course name		Workload (CP)	Form of Teaching	Contact Hours per Week					
	04-10-0624-vu	Optimization Methods fo Maschine Learning	or	0	Lecture and Exercise	3					
2	Study Content Foundations of Maschine learning, Classification (Support Vector Maschines), Matrix Completion, Sparse Regression, Lasso, Neural Networks (Deep Learning)										
3	Learning Outcomes After taking the course, the students have insight into maschine learning. In particular, they know which mathematical optimization methods can be applied in this context and know their properties.										
4	-	for Participation : Introduction to Optimi	ization, Di	screte Optimizatior	n or Nonlinear Oj	otimization					
5	Form of Examination Final Module Examination:										
	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)										
	Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.										
6	Requirements Passing Fachpri	on the Award of Credit üfung	Points								
7	• Modul	Grading Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Weight: 100%,									
8	Standa Usability of the	·									
		atics, Mathematics in Da	ata Scienc	e							
9	Literature Hastie, Tibshira	ini, Friedman: The Eleme	ents of Sta	atistical Learning, Sp	pringer 2000						

	Mitchell: Machine Learning. Mcgraw-Hill 1997 Murphy: Machine Learning: A Probabilistic Perspective, MIT Press 2012 Sra,Nowozin, Wright: Optimization for Machine Learning, MIT Press, 2012 Miroslav Kubat: An Introduction to Machine Learning.Springer, 2015.
10	Comment

	Opti	mizatio	n Metho	ods in Data Scienc	e						
04-	dule no. Credit Points Workloa		Workload 150 h	Self-study		Duration 1 Semester		Frequency Every 2. semeste			
	Language of Instruction English					on responsik . Dr. rer. nat.			ule		
1	Course	s of the	Module								
	Course no.		Course	burse name		Workload (CP)	Form Teacl		Contact Hours per Week	
	04-10-0	625-vu	Optimiza Science	ation Methods in Data	a 0			Lecture and 3 Exercise		3	
2 3	data pr models	•	tive and	arse) principal comp adversarial models		•	-	k-meai	ns, semi	definite	
4	-	ements f mended:		cipation ction to Optimizatio	on; Di	screte Optim	ization o	r Nonli	near Op	timization	
5		Form of Examination Final Module Examination:									
	•	 Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) 									
		Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The									

	decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M. Sc. Mathematics, Mathematics in Data Science
9	Literature Hastie, Tibshirani, Friedman: The Elements of Statistical Learning, Springer 2000 Mitchell: Machine Learning. Mcgraw-Hill 1997 Murphy: Machine Learning: A Probabilistic Perspective, MIT Press 2012 Sra,Nowozin, Wright: Optimization for Machine Learning, MIT Press, 2012 Miroslav Kubat: An Introduction to Machine Learning.Springer, 2015.
10	Comment

Мо	dule nan	ne											
	Parti	al Diffe	rential E	quations I									
Module no. 04-10- 0626/en		Credit Points 9 CP		Workload 270			tudy 180 h	Duration 1 Semester		Frequency Every 2. semeste			
Language of Instruction English						Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber							
1	Course	s of the	Module										
	Course no. Course name					Workload (CP)		CP)	Form of Teaching		Contact Hours per Week		
	04-10-0626-vu Partial E		Partial D	ifferential Equations I			0		Lecture and Exercise		6		
2	Classica			nportant types of ormulation of ell	•								

	Sobolev spaces, Galerkin methods, fixed-point methods for non-linear elliptic and parabolic equations, theory of weak solutions for equations in fluid mechanics
3	Learning Outcomes Students understand and are able to apply the notions, methods and results treated in the course. They develop an advanced level of understanding of partial differential equations and are able to extend their knowledge in this field.
4	Requirements for Participation Recommended: Functional Analysis
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard) Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module M. Sc. Mathematics, Mathematics in Data Science
9	Literature L.C. Evans: Partial Differential Equations (AMS) D. Gilbarg, N.S. Trudinger: Elliptic Partial Differential Equations of Second Order (Springer) M. Renardy, R.C. Rogers: An Introduction to Partial Differential Equations (Springer)
10	Comment

Мо	dule nam	ne								
	Mach	nine Lea	arning fo	or Fluid Dynamics						
04-	dule no. 10- .7/en	Credit F	Points 5 CP	Workload 150 h	Self-study 150 h		Duration 1 Semester		Frequency Irregular	
	guage of lish	Instruct	ion			n responsib Dr. rer. nat.			ule	
1		s of the	Module		ļ					
	Course no. Course		name	V	Workload (CP)		Form Teach		Contact Hours per Week	
	04-10-0	627-vu	Machine Dynamic	e Learning for Fluid cs	0			Lectur Exercis		0
unstructured Finite Volume method. The ALE and VOF methods for simulating incom two-phase flows. Deep Learning (DL) for general function approximation. Deep Learn segregated solution algorithms for NSE. Physics-informed Machine Learning (Pi-ML) - collocation method with Artificial Neural Networks. Designing Pi-ML models for segre solution algorithms for NSE, and curvature approximation for two-phase flows.								ep Learn Pi-ML) - or segre	ing for a	
3	The stu transfe method constru Equatio	r from fi d, and de ds. The s action an ons. In ex lows usi	in derive rst princi escribe th tudents id trainin kercsies,	Navier-Stokes equa iples, they can discr ne relevant algorith can describe the tra g of a Physics-Infor students gather har FOAM, and designir	etize PI ms of th iining pi med Ne nds-on	DEs using the ALE and rocess of a eural Netwo experiences	ne unstruct VOF two- Deep Neu ork for (co s in simula	ctured phase ural Ne pupled ating in	finite vo flow sim twork, a) Partial ncompre	lume nulation nd the Differential essible two-
4	-		for Partio : Partial I	cipation Differential Equation	ns					
5		f Examir odule E>	nation kaminatio	on:						
	• Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)									

r	
	Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	M. Sc. Mathematics, Mathematics in Data Science
9	Literature
	Moukalled, F., Mangani, L., amp; Darwish, M. (2016). The finite volume method. In The finite volume method in computational fluid dynamics (pp. 103-135). Springer, Cham.
	Maric, Tomislav, Jens Hopken, and Kyle Mooney. "The OpenFOAM technology primer." (2014).
	Karniadakis, G. E., Kevrekidis, I. G., Lu, L., Perdikaris, P., Wang, S., amp; Yang, L. (2021). Physics- informed machine learning. Nature Reviews Physics, 3(6), 422-440.
	Physics-Based ML in OpenFOAM - OpenFOAM Workshop Training: https://youtu.be/uKo3RD3yYrU?list=PLwSEyKg12dVYbpC2wy_RT2
10	Comment

Мо	dule nan	ne										
	Repr	esentati	ion The	ory								
Module no. 04-10- 0628/en		Credit P	oints 5 CP	Workload	150 h	Self-s	-	h	Duration 1 Semester		Frequency Irregular	
	nguage of Instruction Person responsible for the Module Prof. Dr. rer. nat. Nils Scheithauer											
1	Course	s of the I	Module									
	Course	no.	Course	name			Workload (CP)		,	Form of Teaching		Contact Hours per

					Week						
	04-10-0378-vu	Representation Theory	0	Lecture and Exercise	3						
2	Study Content Complex representations of finite groups, irreducibility, complete reducibility, Maschke's theorem, Schur's lemma, tensor product, symmetric product, wedge product, character theory, group algebra, representations of the symmetric group, arbitrary ground field, division algebras, splitting fields, restriction and induction, modular representations.										
3		re familiar with the basic res x numbers. They are able to		•	• •						
4	Requirements for Participation Lineare Algbra, Algebra, Einführung in die Algebra										
5			amination, oral /	written Examination, Du	uration 60						
6	Requirements	on the Award of Credit Poin	ts								
7	Grading Final Module E Modul Standa	e Examination (Technical Ex	amination, oral /	written Examination, W	eight: 100%,						
8		e Module ertiefungsbereich gänzungsbereich									
9		resentation theory, ar Representations of Finite	Groups.								
10	Comment										

Мо	dule nam	ne									
	Para	bolic PD)Es								
	dule no. 10-0629			Workload 150 h	Self-study Duratio			• •		-	
	guage of	Instruct		150 11	Dorc	on responsib	l		-	•	
	man and					Prof. Dr. rer.					
1	Courses of the Module										
	Course no.		Course name			Workload (CP)			of ning	Contact Hours per Week	
	04-10-0	629-vu	Paraboli	c PDEs	0			Lecture Exercis		3	
2	Study Content Explicit solutions to the heat equation, existence and uniqueness of solutions to selected nonlinear parabolic PDEs, maximum and comparison principles, qualitative behavior of solutions (e.g. regularity, asymptotic behavior, blow-up)										
3	After at are able of para	e to appl bolic PD	e of the y them t Es. They	module students kr o specific problems know different aspe solution properties	. They ects o	y develop an f the qualitat	advanced ive behav	level	of under	standing	
4	-		or Partic Funktior	cipation nalanalysis							
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard) Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking										
 6 Requirements on the Award of Credit Points Passing the Technical Exam (Fachprüfung) 											

7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Master of Science Mathematics Master of Science Mathematik Advanced Course and Additional Courses in Mathematics
9	Literature L.C. Evans: Partial Differential Equations, AMS G.M. Lieberman: Second Order Parabolic Differential Equations, World Scientific P. Quittner, Ph. Souplet: Superlinear Parabolic Problems. Blow-up, Global Existence and Steady States, Birkhäuser
10	Comment

		iematit		atistics for B	10105							
Module no.		o. Credit Points W		Workload	Workload S		study	Duration		Frequency		
04-10-0630 6 CP 180 h			180 h	105 h 1 Semeste			ter Every 2. semester					
Language of Instruction					Pers	on responsib	le for the	Modu	ıle			
Gei	rman					Prof.	Dr. rer. nat.	Volker M	artin B	letz		
1	Course	s of the	Module									
	Course no.		Course name		Workload (CP)		CP)	Form of Teachin		Contact Hours per Week		
	04-00-0119-vu Mathen Biologis			natics and Statistics for ts		0		Lecture and Exercise		5		
2	Study C	Study Content										
	and interestimates and interesti	sets and operations with sets, sequences and infinite series, basics of differential and integral calculus, ordinary differential equations; statistical measurements, calculus of regression, estimating densities; probability measures, random variables and distributions, expectation and variance, independence of random variables, law of large numbers and central limit theorem; point estimators and domain esstimators; statistical tests										

3	Learning Outcomes
	Die Studierenden werden mit einigen grundlegenden Konzepten aus der Mathematik
	vertraut gemacht und erwerben darauf aufbauend grundlegende
	Kenntnisse über ausgewählte Bereiche der Statistik, insbesondere im Zusammenhang
	mit Punktschätzverfahren, Bereichsschätzverfahren und statistischen
	Tests. Ziel dabei ist einerseits, den Studierenden ein für die richtige
	Anwendung und Interpretation (der Resultate) von statistischen Verfahren
	entscheidendes Verständnis für die mathematische Modellierung des Zufalls
	und darauf aufbauender statistischer Schlussweisen zu vermitteln, und
	anderseits eine Reihe von statistischen Verfahren mit Anwendbarkeit bei
	biologischen Fragestellungen vorzustellen.
4	Requirements for Participation
5	Form of Examination
5	
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Duration 60
	min, Standard)
	Usually the exam is taken in form of a written test, except when there are only a small number
	of potential participants. In this case, the exam can be taken in the form of an oral exam. The
	decision about the form of the exam is taken and communicated
	during the first two weeks of the lecture, based on the prospective number of students taking
	the exam.
6	Requirements on the Award of Credit Points
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	Obligatory
9	Literature
	Freedman, Pisani, Purves: Statistics. Notron, 1998 Fahrmeir, Künstler, Pigeot,
	Tutz: Statistik. Der Weg zur Datenanalyse. Springer, 2001 Quinn,
	Keough: Experimental Design and Data Analysis for Biologists. Cambridge,
	2007
10	Comment
1	

04-1 0023	.1-	Cradit [
Lang	<i>, uc</i>	Module no.Credit PointsWorkload04-11-5 CP1500023/de5 CP150		Self-study Duration 105 h 1 Semest		•		e ncy 1. semester						
-	Language of Instruction			Person responsible for the N				Madula						
		mstruct				Dr. rer. nat.								
1	Courses	s of the l	Module											
	Course no.		Course	Course name		Workload (CP)		Form of Teaching		Contact Hours per Week				
	04-11-0023-vu		Mathematics in Context			0		Lecture and Exercise		3				
3	 -Infinity from Zenon to Cantor; -Infinitely small quantities, measure theory, and non-standard analysis; -School mathematics versus university mathematics 													
-	Learning Outcomes Based on various concrete mathematical contents students acquire the competence to give an account of mathematics in its interactions with culture and society, to assess the role of mathematics in different contexts, and to represent mathematics adequately in a professional environment as well as in the public.													
4	-		or Parti o Analysis	cipation and Linear Algebra										
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) 													
		-		• •	Studienleistung: Oral exams in small groups, as well as successful participation in the exercise classes where appropriate.									

7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module B.Sc. Mathematik (PO 2018 und PO 2024)
9	 Literature Victor Katz: A History of Mathematics. Harper Collins, 1993. C. Boyer: A History of Mathematics. John Wiley, 1968ff. C. C. Gillispie: Dictionary of Scientific Biography. Charles Scribner's Sons, 1970 - 1991. P. J. Davies, R. Hersh: Erfahrung Mathematik. Birkhäuser, 1994. M. Kline: Mathematical Thought from Ancient to Modern Times. Oxford University Press, 1972. H. Wußing: 6000 Jahre Mathematik. Springer, 2008.
10	Comment recommended: Mathematics: Bachelor year 2

Мос	lule nan	ne								
	Торо	logy								
Module no. 04-11- 0031/de		Credit Points 5 CP		Workload 150		f-study 105 h	Duration 1 Semester		Frequency Irregular	
Language of Instruction German				Person responsible for the Module Prof. Dr. rer. nat. Nils Scheithauer						
1	Course	s of the	Module		_,					
	Course no. Cour		Course	e name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0020-vu Topol		Topolog	39		0		Lecture and Exercise		3
2	Study Content separation axioms, compactness, function spaces, connectedness, fundamental group and covering maps and spaces									
3		g Outco								
				d and are able to a						
	course. They have a basic understanding of topological concepts and are able to recognise them									

	in various fields of mathematics.
4	Requirements for Participation
	recommended: Analysis, Introduction to Algebra
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Munkres: Topology, Prentice Hall Bredon: Topology and Geometry, Springer Ossa: Topologie, Vieweg Hatcher: Algebraic Topology, Cambridge University Press Dugundji: Topology, McGraw-Hill Kelley: General Topology, Ishi Press
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

Module name										
Торо	logy									
Module no.	Credit Points	Workload	Self-study		Duration	Frequency				
04-11- 0031/en	5 CP	150	-		1 Semester	Irregular				

	nguage of Instruct	tion		on responsible for						
	glish		Prot	. Dr. rer. nat. Nils S	cheithauer					
1	Courses of the Course no.	Module Course name	Workload (CP)		Form of Teaching	Contact Hours per Week				
	04-00-0020-vu	Topology		0	Lecture and Exercise	3				
2	Study Content separation axioms, compactness, function spaces, connectedness, fundamental group and covering maps and spaces									
3	course. They ha	o mes nderstand and are able to a ave a basic understanding o s of mathematics.								
4	-	for Participation Analysis, Introduction to A	lgebra							
5	Fachprüfung: U small number c exam. The deci:		form c this ca exam i	of a written test, ex se, the exam can b s taken and comm	cept when there e taken in the fo unicated	are only a rm of an oral				
6	Requirements Passing the Fac	on the Award of Credit Poin	nts							
7	Grading Final Module Ex Modul Standa	e Examination (Technical Ex	kamina	ation, oral / written	Examination, W	eight: 100%,				
8	Usability of the B.Sc. Mathema	e Module tik (PO 2018), M.Sc Mathen	natik (PO 2018), M.Sc. Ma	athematics					
9		logy, Prentice Hall gy and Geometry, Springer e, Vieweg								

	Hatcher: Algebraic Topology, Cambridge University Press Dugundji: Topology, McGraw-Hill Kelley: General Topology, Ishi Press
10	Comment recommended: Mathematics: Bachelor year 3 (alg)

Мо	dule nam	ne								
Discrete MathematicsModule no.Credit PointsWorkload04-11-9 CP270						Self-study Duration 180 h 1 Semes				-
Lan	guage of	Instruct	ion	<u> </u>		on responsib			ule	
1 Courses of the Mod		Module Course	name		Workload ((CP)	Form Teacl	-	Contact Hours per Week	
	04-00-0	137-vu	Discrete	Mathematics		0		Lectur Exercis		6
3	triangu Learnin Studen [:] - recogi - under	atorics, lations o g Outco ts attenc nize disc stand ge	f convex mes ling this rete stru neral dis	ng functions, solvin polygons, planar gr course will ctures with far reac screte concepts and various counting co	hing	connections	y, design	s		
4	-		or Partio Algorith	cipation mic Discrete Mathe	matio	cs				
5	Final M • Fachpri when th	Module ifung (Te nere are	aminatio e Examir echnical only a si	on: hation (Technical Exa Examination): Usua mall number of pote oral exam. The decis	lly th ential	e exam is tak participants.	en in fori In this c	m of a v ase, the	written e exam	test, except can be

	communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik
9	 Literature M. Aigner, Diskrete Mathematik, 5. Auflage, Vieweg, 2003. R. L. Graham, D. E. Knuth and O. Patashnik, Concrete Mathematics, Second edition, Addison-Wesley, Reading, MA, 1994. W. Koepf, Hypergeometric Summation. An Algorithmic Approach to Summation and Special Function Identities, AMS, 1998. J. Matoušek, J. Nešetril, Diskrete Mathematik. Eine Entdeckungsreise, Springer, 2002. R.P. Stanley, Enumerative Combinatorics, Volume I, Cambridge 1997. J.H. van Lint, R.M. Wilson: A Course in Combinatorics, Cambridge University Press, 2009.
10	Comment recommended: Mathematics: Bachelor year 3 (opt), Teaching Degrees

Mo	dule nam	ne									
	Num	erical L	inear Al	gebra							
Module no. 04-11- 0043/deCredit Points 5 CPWorkload0043/de5 CP150 I						Self-stu	dy Duration Frequency 105 h 1 Semester Every 4. seme			•	
Language of Instruction German 1 Courses of the Module					Person responsible for the Module Dr. rer. nat. Alf Gerisch						
	Course	no.	Course	name		W	orkload ((CP)	Form Teach		Contact Hours per Week
	04-00-0	139-vu	Numeric	al Linear Algebra		0			Lecture Exercis		3

2	Study Content Systems of linear equations: iterative methods, singular value decomposition, eigenvalue problems.
3	Learning Outcomes Students know about the most important numerical methods of linear algebra and they are able to explain, classify, and apply them.
4	Requirements for Participation recommended: Linear Algebra, Introduction to Numerical Analysis or similar knowledge
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Trefethen/Bau: Numerical Linear Algebra, SIAM Demmel: Applied Numerical Linear Algebra, SIAM Stoer/Bulirsch: Numerische Mathematik 2, Springer
10	Comment recommended: Mathematics: Bachelor year 3 (num)

Module name

	Num	erical Li	inear Al	gebra														
04-1	dule no.	Credit F		Workload	150 h		study 105 h	Duration 1 Semes			-							
Lanք Engl	guage of ish	Instruct	ion				on responsib er. nat. Alf Go		e Modu	le								
1	Course	s of the	Module															
	Course	no.	Course	name			Workload ((CP)	Form Teach		Contact Hours per Week							
	04-00-0	139-vu	Numeric	al Linear Alge	ebra		0		Lecture Exercis		3							
2	Study C System probler	s of linea	ar equati	ons: iterativ	e meth	ods, s	ingular value	decomp	osition	, eigenva	alue							
3	Learning Outcomes Students know about the most important numerical methods of linear algebra and they are able to explain, classify, and apply them.																	
4	-		f or Partic Linear A	-	oduction	n to N	umerical Ana	lysis or s	imilar l	knowled	ge							
5	Final M Fachpri when th taken ir commu	Module ifung (Te nere are n the for nicated	camination e Examin echnical only a sr m of an o	eation (Tech Examinatior mall number oral exam. T ne first two	n): Usua r of pote The deci	lly the ential sion a	ation, oral / w e exam is take participants. bout the form lecture, base	en in forn In this ca n of the e	n of a v ase, the exam is	written t e exam c s taken a	est, except an be and							
6	•		on the A hprüfunរ្ខ	ward of Cre g	dit Poin	its												
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 																	
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics																	

9	Literature Trefethen/Bau: Numerical Linear Algebra, SIAM Demmel: Applied Numerical Linear Algebra, SIAM Stoer/Bulirsch: Numerische Mathematik 2, Springer
10	Comment recommended: Mathematics: Bachelor year 3 (num)

Мо	dule nan	ne								
	Intro	duction	to Mat	hematical Financo	e					
Module no. 04-11- 0047/de		Credit F	Points 5 CP	Workload S 150 h		Self-study 105 h		1 ter	Frequency Every 2. semester	
	Language of Instruction German					on responsib . Dr. rer. nat.			le	
1	Course	s of the	Module							
	Course no.		Course	name		Workload ((CP)	Form Teach		Contact Hours per Week
	04-00-0	084-vu	Introduc Finance	tion to Mathematical	0		Lecture and Exercise		3	
	-	oreises, l		nzen, Ein-Perioden-I el, Black-Scholes-Fo			-		-	
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of financial mathematics Students are able to contextualize subject matter within the social context, critically assess the consequences, and act ethically and responsibly accordingly.									
4	-		or Parti Introduc	cipation ction to Stochastics,	Prot	ability Theor	ý			
5		f Examir odule E>	ation amination	on:						

	Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature
	Bingham, Kiesel: Risk-Neutral Valuation;
	Elliott, Kopp: Mathematics of Financial Markets;
	Irle: Finanzmathematik;
	Musiela, Rutkowski: Martingale Methods in Financial Modelling; Pliska: Introduction to Mathematical Finance;
	Shreve: Stochastic Calculus for Finance I (Discrete Time Models)
10	Comment
	recommended: Mathematics: Bachelor year 3 (sto)
1	

Мо	dule nam	ie									
	Discr	ete Opti	mizatio	on		-					
Мо	dule no.	Credit P	oints	Workload		Self-s	tudy	Duration	1	Freque	ency
04-	11-0073		9 CP		270 h		180 h	1 Semest	ter	Every 2	2. semester
Lan	guage of	Instructi	on			Perso	n responsib	le for the	Modu	ule	
Ger	man and	English				Prof.	Dr. rer. nat.	Marc Pfet	tsch		
1	Courses	s of the N	/lodule								
	Course	no.	Course	name			Workload ((CP)	Form Teacł	-	Contact Hours per Week

	04-00-0027-vu	Discrete Optimization	0	Lecture and Exercise	6
2	polyhedral com	ems of linear equalities ar binatorics; methods: exac iristics, relaxations	•		•
3		ding this course will maste onally be able to model d			
4	-	for Participation Introduction to Optimiza	ition, Algorithmic Di	screte Mathematics	
5	Form of Examir Final Module Ex		Examination oral /	written Examination C	tandard)
	Fachprüfung (To when there are taken in the for	echnical Examination): Us only a small number of p m of an oral exam. The d during the first two week	sually the exam is ta potential participant ecision about the fo	ken in form of a written s. In this case, the exam rm of the exam is taken	test, except can be and
6	Requirements of Passing the Fac	on the Award of Credit Pe	oints		
7	Grading Final Module Ex • Module Standar	e Examination (Technical	Examination, oral /	written Examination, W	eight: 100%,
8	Usability of the B.Sc Mathemat	Module ik, M.Sc. Mathematik, M.	Sc. Mathematics		
9	Schrijver: Theor	olsey: Integer and Combir ry of Linear and Integer Pi Combinatorial Optimizatio	rogramming, Wiley	· · · · · · · · · · · · · · · · · · ·	
10	Comment recommended:	Mathematics: Master (op	pt)		

Мо	dule nan	ne								
	Nonl	inear O	ptimizat	tion						
Мо	dule no.	Credit F	Points	Workload	Self-	study	Duration		Freque	ncy
04-:	11-0074		9 CP	270 h		180 h	1 Semes	ter	Every 2	. semester
Lan	guage of	Instruct	ion		Pers	on responsib	le for the	e Modu	ule	
Ger	man and	English			Prof	. Dr. rer. nat.	Stefan U	lbrich		
1	Courses of the Module							1		
	Course	no.	Course	name				Form Teach	-	Contact Hours per Week
	04-00-0	174-vu	Nonlinea	ar Optimization	-			Lecture and Exercise		6
	Modelling of practical applications as optimization problems; optimality conditions, duality theory; methods for unconstrained problems: Linesearchand Trust-Region-Methods; method for constrained problems: penalty-, interior-point-, multiplier- and SQP-methods							•		
3	Learning OutcomesStudents- can model practical optimization instances as mathematical optimization problems- know methods for the solution of unconstrained optimization problems and their convergenceproperties- know the optimality theory of nonlinear optimization and are able to apply it- know methods for the solution of constrained optimization problems and their convergenceproperties									
4	-		f or Partic Introduc	cipation ction to Optimizatio	n					
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, exce when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam. 						est, except can be and			

6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Geiger, Kanzow: Numerische Verfahren zur Lösung unrestringierter Optimierungsaufgaben Geiger, Kanzow: Theorie und Numerik restringierter Optimierungsaufgaben Nocedal, Wright: Numerical Optimization
10	Comment
	recommended: Mathematics: Master (opt)

Мос	lule nan	ne									
	Side-	Channe	el Attacl	ks on IT Sys	tems						
Moc 04-1 0218	-	Credit Points 5 CP		Workload	150 h		study 105 h	Duratior 1 Semes	-	Frequency Irregular	
Language of Instruction German							on responsib Prof. Dr. rer.				
1	Course	s of the	Module								
	Course no. Course		name			Workload (CP)		Form Teach	•••	Contact Hours per Week	
	04-00-0218-vu Side-Cha Systems		annel Attacks on IT			0		Lecture and Exercise		3	
2	Study C	Content									
	Mathematics: Modelling side-channel information in terms of stochastic processes, statistical decision theory, multivariate statistics, elementary statistical methods, elementary number theory (aims: understanding und developing side-channel attacks, optimal exploitation of side-channel information). Cryptography and IT security: Timing Attacks, power attacks.										
3	Learnin	g Outco	mes								
	Studen	ts									

	- understand and are able to apply the notions, methods and results treated in the course
	- develop a basic level of understanding of side-channel attacks
	- are able to recognise the treated concepts in various fields of mathematics.
4	Requirements for Participation
	recommended: Analysis, Linear Algebra, Introduction to Stochastics or equivalent qualification required; familiarity of cryptography is desirable
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature
	HO. Georgii: Stochastik - Einführung in die Wahrscheinlichkeitstheorie und Statistik. 5. Auflage, De Gruyter, Berlin 2015.
	F.E. Beichelt, D.C. Montgomery: Teubner Taschenbuch der Stochastik -
	Wahrscheinlichkeitstheorie, Stochastische Prozesse, Mathematische Statistik. Teubner, Wiesbaden 2003.
	O.J.W.F. Kardaun: Classical Methods of Statistics. Springer, Berlin 2005.
	J. Buchmann: Einführung in die Kryptographie. 5. erw. Auflage, Springer, Berlin
	S. Mangard, E. Oswald, T. Popp: Power Analysis Attacks - Revealing the Secrets of Smart Cards.
	Springer, Berlin 2007. and a number of relevant papers
10	Comment

Мо	dule nan	ne								
	Com	plex An	alysis II							
04-:	dule no. 11- .7/en	Credit F	Points 5 CP	Workload 150 h	Self-	study 105 h	Duratior 1 Semes	-	Freque Irregula	-
	guage of lish	Instruct	ion			on responsib Dr. rer. nat.				
1		s of the	Module		1101.		Jun nena			
-	Course no. Course			name	name		Workload (CP)		of ning	Contact Hours per Week
	04-00-0	226-vu	Complex	Analysis II		0		Lecture Exercis		3
	Conformal mappings, Möbius transformation, Riemann's mapping Theorem; partial fractions, infinite products, Gamma function, elliptic functions and curves; entire functions; range of analytic functions; Little and Great Picard theorems							-		
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of respective methods - are able to recognise the treated concepts in various fields of mathematics.									
4	•		or Partic Complex	c ipation « Analysis						
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.									
6	-		on the A hprüfunរ្	ward of Credit Poin	its					

7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature
	J.B. Conway: Complex Analysis I, II, Springer.
	L.V. Ahlfors: Complex Analysis, McGraw-Hill
	Chr. Pommerenke: Boundary Behaviour of Conformal Maps, Springer
	E. Freitag, R. Busam: Funktionentheorie 1, Springer
10	Comment
	recommended: Mathematics: Bachelor year 3 (alg)

04-	odule no. -11- 33/de Credit Points 9 CP		dations of Comp Workload 270 h	Self	study Durati 180 h 2 Sem		-	Frequency Every 2. semest		
	iguage of rman	Instruc	tion			on responsib . Dr. rer. nat.			ıle	
1	Course Course		Module Course	name		Workload ((CP)	Form	of	Contact
	course		course					Teaching		Hours per Week
	04-00-0	04-00-0090-vu		ional Logic and Pred	cate	nte 0			Lecture and Exercise	
	04-00-0	04-00-0091-vu Automa Decidab		ta, Formal Languages and ility		0		Lecture and Exercise		3
2	Study Content finite automata and regular languages, Kleene Theorem, Myhill–Nerode Theorem, grammars and Chomsky hierarchy, context-free languages, pumping lemmas, models of computation, PDA Turing machines, decidability and recursive enumerability; propositional logic: compactness, complete proof calculi; first-order logic: structures and assignments, Skolemisation, Herbrand Theorem, compactness theorem, complete proof calculi (Gödel's completeness result), undecidability of first-order logic; optional: digressions on expressiveness and model checking									

3	Learning Outcomes Students understand and are able to apply the notions, methods and results treated in the course. They have developed a basic level of understanding of formal language theory, basic computability theory and of methods of mathematical logic in application to fundamental issues in theoretical computer science. They are able to recognise the relevant concepts and ideas in related fields of mathematics and theoretical computer science.
4	Requirements for Participation recommended: solid mathematical foundations in Analysis and Linear Algebra
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, Ergänzungsbereich M.Sc.
9	Literature Hopcroft, Motwani, Ullman: Einführung in die Automatentheorie, formale Sprachen und Komplexitätstheorie Schöning: Theoretische Informatik – kurz gefasst Boolos, Burgess, Jeffrey: Computability and Logic Burris: Logic for Mathematics and Computer Science Skripte (elektronisch unter <u>www.mathematik.tu-darmstadt.de/~otto</u>)
10	Comment recommended: Mathematics: Bachelor year 2

Мос	dule nam	ne								
	PDE	I.C Hvd	romech	anics						
Мос	dule no.	-		Workload	Self-s	Self-study Durati			on Frequency	
04-1	1-0254		5 CP	150 h		105 h	1 Semes	ter	Irregul	ar
	guage of		ion			on responsib				
	man and	-			Prof.	Dr. rer. nat.	Matthias	Hiebe	r	
1		s of the								
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-11-0254-vu PDE II.C			Hydromechanics		0		Lecture Exercis		3
2	Study Content Development and analytical treatment of the fundamental equations of hydrodynamics, boundary layers, Euler equation, geophysical models									
	Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of hydromechanics - are able to extend their knowledge in this field - are able perform supervised research in this field							ourse		
4	•		or Partic Function	ipation nal Analysis, Partial	Differe	ential Equati	ons l			
5			aminatio							
	• Module Examination (Technical Examination, oral / written Examination, Standard)									
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, ex when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number students taking the exam.						can be and			
6	Requirements on the Award of Credit Points Passing the Fachprüfung									
	0		որսութ	b						

	 Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Galdi: An introduction to the mathematical theory of the Navier-Stokes equations. Springer Verlag Sohr: The Navier-Stokes equations. An elementary functional analytic approach. Birkhäuser Verlag Temam: Navier-Stokes equations. Theory and numerical analysis. North- Holland Publishing Co.
10	Comment recommended: Mathematics: Master (ana) Builds on "Partial Differential Equations I". Upon approval, contents of two PDE II.X-courses may replace "Partial Differential Equations II" and can be combined with the content from "Partial Differential Equations I" as an "Advanced Course in Analysis". Combinations of two or more PDE II.X-courses as additional courses require approval, too.

Мо	dule nan	ne									
	Four	ier Anal	ysis								
Module no. 04-11- 0263/de		Points 5 CP	Workload	150 h		study 105 h	Duration 1 Semester		Frequency Irregular		
Language of Instruction German					Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber						
1	Courses of the Module										
	Course	no.	Course	name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0256-vu Fourier		Analysis			0		Lecture and Exercise		3	
2	-	Content on-Zygm	und sing	ular integral o	perate	ors, in	terpolation,	Fourier t	ransfor	mation	, multipliers

3	Loarning Outcomes
5	Learning Outcomes Students
	- understand and are able to apply the notions, methods and results treated in the course
	- develop a basic level of understanding of singular integrals and singular integral operators
	 are able to recognise the treated concepts in various fields of mathematics.
4	Requirements for Participation
	recommended: Analysis, Gewöhnliche Differentialgleichungen, Complex Analysis.
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature
	W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999.
	W. Rudin, Real and Complex Analysis, McGraw Hill, 3. Auflage 1987.
	E. Stein, Harmonic Analysis, Princeton University Press.
	L. Grafakos, Classical and Modern Fourier Analysis, Springer.
10	Comment
	recommended: Mathematics: Bachelor year 3 (ana)

Module name

Fourier Analysis

04-1	dule no. .1- 3/en	Credit F	Points 5 CP	Workload	150 h	Self-s	•	Duration 1 Semes	-	Freque Irregul	-
Lanք Engl	guage of ish	Instruct	ion				n respons i Dr. rer. nat				
1	Course	s of the l	Module								
	Course	no.	Course	name			Workload	(CP)	Form Teach	-	Contact Hours per Week
	04-00-03	256-vu	Fourier /	Analysis		()		Lecture Exercis		3
2	Study C Calderc		und sing	ular integral	operat	ors, int	erpolation	, Fourier ti	ransfor	mation	, multipliers
3	Studen - under - develo	stand an op a basi	id are ab c level o	le to apply t f understan he treated c	ding of s	singula	r integrals	and singul	ar inte		
4	-		ior Partic Analysis	c ipation , Gewöhnlic	he Diffe	erentia	lgleichunge	en, Comple	ex Anal	ysis.	
5	Final M Fachpri when tl taken ir commu	Module ifung (Te here are n the for inicated	aminatio e Examin echnical only a si m of an	nation (Tech Examinatior mall numbe oral exam. T ne first two	n): Usua r of pote The deci	lly the ential p sion at	exam is ta participant pout the fo	ken in forn 5. In this ca rm of the e	n of a v ase, the exam is	written e exam s taken	test, except can be and
6	-		on the A hprüfunរ្	ward of Cre ु	dit Poin	ts					
7	Grading Final M	odule Ex		on: nation (Tech	nical Ex	aminat	ion, oral /	written Ex	aminat	ion, We	eight: 100%
8		-	Module tik, M.Sc	Mathemati	k, M.Sc.	Mathe	ematics				

9	Literature W. Rudin, Reelle und komplexe Analysis, Oldenbourg Verlag 1999. W. Rudin, Real and Complex Analysis, McGraw Hill, 3. Auflage 1987. E. Stein, Harmonic Analysis, Princeton University Press. L. Grafakos, Classical and Modern Fourier Analysis, Springer.
10	Comment recommended: Mathematics: Bachelor year 3 (ana)

	Gam	e Theor	'Y						
04-	dule no. 11- 2/de	Credit I	Points 5 CP	Workload 150 h	Self-study 105 h	Duration 1 Semest		Frequer Irregula	-
	guage of man	Instruct	ion		Person responsib Prof. Dr. rer. nat.			le	
1	Course	s of the	Module						
	Course	no.	Course	name	Workload ((CP)	Form Teacł		Contact Hours per Week
	04-10-0	320-vu	Game Th	neory	0		Lecture Exercis		3
	games. Non-co games, solutior	operativ zero-su	re game t m and no me (e.g.	ry: coalitions, solutions, solutions, solution theory: Sequential a ph-zero-sum games, Nash equilibrium). eorem) and impossi	nd strategic game discrete and cont Fixed point theore	s, two-pe inuous ga ms (e.g. B	rson a imes. \ Brouwe	nd n-pers /arious co er). Existe	son oncepts of ence
		ng Outco	mes						
3	Studen underst They ca models analyze	ts are fa tand fun an illustra of simp games a	damenta ate and o le applica and to ju	th different aspects al (solution) concept discuss abstract con ations. They are abl udge the results wit s numerically.	ts in cooperative o cepts using examp e to prove and app	r noncoop les and co ply mathe	perativ onstru matica	ve game t ct game t al theorer	heory. theoretic ms to

5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature
	Osborne: An Introduction to Game Theory
	Forg, Szép und Szidarovszky: Introduction to the Theory of Games Krabs: Spieltheorie: Dynamische Behandlung von Spielen
	Berninghaus, Ehrhart und Güth: Strategische Spiele
10	Comment
	recommended: Mathematics: Bachelor year 3 (opt)

Mo	dule nan	ne										
	Math	nematica	al Foun	dations of	Quantı	um Me	echanic	s				
04-2	dule no. 11- 8/de	Credit P	oints 5 CP	Workload	150 h	Self-s	-)5 h	Duration 1 Semester		Freque r Irregula	•
	guage of man	Instruct	ion				•		le for the N Burkhard K			
1	Course	s of the N	Module			•						
	Course	no.	Course	name			Workloa	ad (C		orm each		Contact Hours per

	I	Γ				
						Week
	04-10-0328-vu	Mathematical Foundations of Quantum Mechanics	0		ecture and Exercise	3
2	mechanics and and time depen	s versus quantum mechanics, E their consequences. Observab Ident Schrödinger Equation. Co Itum information	les and self-ad	joint operat	ors. Stone's	Theorem
3	distinguish assu adequacy of ma	mes le to explain and to interpret t imptions motivated by physics athematical methods when app undamental differences betwe	from its mathe plied to proble	ematical cor ms from qua	nsequences, antum mecha	to check the anics, and
4		for Participation Content of the first two years	of a B.Sc. Prog	ramme in N	1athematics of	or Physics.
5	Fachprüfung (To when there are taken in the for	camination: e Examination (Technical Exam echnical Examination): Usually only a small number of potent m of an oral exam. The decisio during the first two weeks of t	the exam is ta tial participant n about the fo	ken in form s. In this cas rm of the ex	of a written se, the exam xam is taken	test, except can be and
6	Requirements of Passing the Fac	on the Award of Credit Points hprüfung				
7	Grading Final Module Ex • Module Standar	e Examination (Technical Exam	ination, oral /	written Exa	mination, We	eight: 100%,
8	Usability of the B.Sc. Mathemat	tik, M.Sc Mathematik, M.Sc. M	athematics			
9	M. Reed, B. Sim	Mathematische Grundlagen de Ion: Methods of Modern Physi Nathematical Foundations of C	cs I.			
10	Comment recommended:	Mathematics: Bachelor year 3	(alg)			

		duction	to Axio	matic Set Theory	[
04-	dule no. 11- 8/de	Credit F	Points 5 CP	Workload 150 h	Self-study 105 h	Duration 1 Semes		Freque Irregula	•
	guage of	Instruct	ion		Person responsil	le for the	Modu	l Ile	
	man				Prof. Dr. rer. nat.				
1	Course	s of the	Module		ł				
	Course	no.	Course	name	Workload (CP)	Form Teach	-	Contact Hours per Week
	04-10-0	338-vu	Introduc Theory	tion to Axiomatic Set	0		Lectur Exercis		3
				e notions of ordinal	and cardinal num	norc and r	nrova c	ome ha	
3	equival Learnin Student recursio	ents like g Outco ts maste on and b	Zorn's le mes r the lan	Furthermore we dia emma and the Well guage and basic me linal (in)qualities. M	scuss the Axiom o Ordering Theorer ethods of set theo	f Choice a n. ry like trai	nd pro	e inducti	e of its
3	equival Learnin Student recursic Choice Require	ents like g Outco ts maste on and b is used. ements f	Zorn's le mes r the lan asic card	emma and the Well guage and basic me linal (in)qualities. M	scuss the Axiom o Ordering Theorer thods of set theo oreover, they can	f Choice a n. ry like trai recognize	nd pro	e inducti the Axi	e of its

	Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Lecture notes provided online. Further reading: Moschovakis "Notes on Set Theory" (Springer 2006)
10	Comment recommended: Mathematics: Bachelor year 3 (log)

Мос	lule nam	ne									
	Appli	ied Geo	metry								
Mod	lule no.	Credit F	Points	Workload		Self-	study	Duratio	n	Freque	ncy
04-1	1-0375		9 CP	2	270 h		180 h	1 Semes	ster	Irregula	r
Lang	guage of	Instruct	ion			Pers	on responsib	le for th	e Modu	ıle	
Gerr	nan and	English				Prof	. Dr. rer. nat.	Ulrich Re	eif		
1	Courses	s of the	Module								
	Course	no.	Course	name			Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-10-03	375-vu	Applied	Geometry			0		Lecture Exercis		6
2	surface	in polyn s, subdiv		Bézier curves, orithms, smoo meshes.	•		•	•		•	•
3	Learnin	g Outco	mes								
	Student					_					
			asic math	ematical prino	ciples	of co	mputer-aideo	d geomet	tric mo	deling of	curves
	and sur										
	- are ab	ie to ass	sess their	significance f	or the	eoreti	cai and applie	ea purpo	ses		

	- thoroughly understand the relationship between analytical properties of the involved function spaces and geometric properties of the manifolds they parametrise.
4	Requirements for Participation
	recommended: Differential Geometry
5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Standard)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and
	communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	
0	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Hoschek und Lasser, Grundlagen der geometrischen Datenverarbertung, Teubner
	Prautzsch, Boehm und Paluszny, Bézier and B-Spline Techniques, Springer
	Peters und Reif, Subdivision surfaces, Springer
	Hoschek und Lasser, Grunglagen der geometrischen Datenverarbertung, Teubner Prautzsch, Boehm und Paluszny, Bézier and B-Spline Techniques, Springer
	Peters und Reif, Subdivision surfaces, Springer
10	Comment
	recommended: Mathematics: Master (geo)

Module nam	ne					
Appr	oximation theo	ory				
Module no.	Credit Points	Workload		Self-study	Duration	Frequency
04-11-0376	9 CP		270 h	180 h	1 Semester	Irregular

	guage of Instruc			responsible for		
	rman and English		Prof. D	r. rer. nat. Ulrich	Reif	
1	Courses of the Course no.	Module Course name	v	/orkload (CP)	Form of Teaching	Contact Hours
					reaching	per Week
	04-10-0376-vu	Approximation theory	0		Lecture and Exercise	6
2	Hilbert lemma, canonical splin	proximation theorem, mu distance spline-control p e interpolant, quasi inter elations, smoothing splin	oolygon, Scl polation, Ja	oenberg-Whitne ckson type theoi	ey theorem, natu rems, uniform sta	ral and ability,
3	splines - recognise the - develop an ur	ey aspects of linear uni- a crucial role of dual funct iderstanding of various m	ionals for s nethods of a	ability and appro	oximation proper	rties
		able methods of approxi	mation to c	oncrete problem	IS	
4	Requirements	for Participation	mation to c	oncrete problem	15	
4	Requirements recommended Form of Examin Final Module E • Modul Fachprüfung (T when there are taken in the for	for Participation Applied Geometry nation xamination: e Examination (Technical echnical Examination): U conly a small number of p rm of an oral exam. The d during the first two wee	l Examinations sually the e potential pa lecision abo	on, oral / written xam is taken in f articipants. In thi but the form of tl	Examination, St form of a written s case, the exam he exam is taken	test, excep can be and
	Requirements recommended: Form of Examin Final Module E • Modul Fachprüfung (T when there are taken in the for communicated students taking	for Participation Applied Geometry nation xamination: e Examination (Technical echnical Examination): U conly a small number of p rm of an oral exam. The d during the first two week the exam.	l Examination sually the e potential pa lecision abo ks of the le	on, oral / written xam is taken in f articipants. In thi but the form of tl	Examination, St form of a written s case, the exam he exam is taken	test, except can be and

	B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature de Boor, A Practical Guide to Splines, Springer Schumaker, Spline functions basic theory, Cambridge University Press Höllig, Finite element methods with B-splines, SIAM
10	Comment recommended: Mathematics: Master (geo)

Mod	ule nam Nonl	-	unctiona	al Analysis							
Mod	ule no.	Credit F	Points	Workload		Self-	study	Duratio	n	Freque	ency
04-1	04-11-0381 5 CP 150						105 h	1 Semes	ester Irregular		
-	g uage of nan and	Instruct English	ion				on responsib . Dr. rer. nat.				
1	Courses of the Module										
	Course	no.	Course	name			Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-11-03	381-vu	Nonlinea	ar Functional Analysis			0		Lecture and Exercise		3
3	bifurcat	tion theo	ory; mon	otone opera			degree theo				ii spaces,
	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop an advanced level of understanding of nonlinear functional analysis - are able to extend their knowledge in this field - are able perform supervised research in this field							Durse			
4	-		f or Partic Functior	ipation nal Analysis							
5			aminatio		ical F		ation cret/	witter Fr	0.001.0.01	ion (t	and and)
	•	Modul	e Examin	ation (Techn	ical Exa	amina	ation, oral / w	vritten Ex	aminat	ion, S	t

	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc Mathematik, M.Sc. Mathematik, M.Sc. Mathematics
9	Literature A. Ambrosetti, G. Prodi: A primer of nonlinear analysis. Cambridge University Press 1993 K. Deimling: Nonlinear functional analysis. Springer 1974 M. Ruzicka: Nichtlineare Funktionalanalysis. Springer 2004
10	Comment recommended: Mathematics: Master (ana)

Mo	dule nan	ne									
	Sobo	lev Spa	ces								
Module no.			Workload	150 h		study 105 h	Duration 1 Semester		Frequency Irregular		
	guage of man and		tion				on responsib Prof. Dr. rer.				
1	Courses of the Module										
	Course	no.	Course	name			Workload ((CP)	Form Teach	•.	Contact Hours per Week
	04-10-0	04-10-0514-vu Sobolev Spaces			0			e and e	3		
2	Study C Constru		Sobolev	Spaces, Emb	pedding	g and	trace theore	ms, Appl	ications	s to Pari	tial

	Differential Equations
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of the theory of Sobolev spaces - are able to recognise the treated concepts in various fields of mathematics.
4	Requirements for Participation recommended: Analysis, Linear Algebra, Integration Theory
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Standard) Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Adams, Fournier: Sobolev Spaces (Academic Press); Evans : Partial Differential Equations (AMS)
10	Comment recommended: Mathematics: Bachelor year 3 (ana)

Module name

Combined Module

04-1	dule no. 13- 1/de	Credit Points Workload Self-study Duration 8 CP 240 h 240 h 1 Semester			Frequency er Every 2. semeste							
Lan g Geri		Instruct	ion			Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger						
1	Courses of the Module Course no. Course name				Workload (CP)		Form of Teaching		Contact Hours per Week			
2	Study C Siehe T	c ontent eilmodul	e									
3		g Outco eweiliges		ıngsmodul u	ind jewe	eiliges	fachdidaktis	sches Sem	ninar			
4	-	e ments f eilmodul		cipation								
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Technical Examination, Standard) 							ard)				
6	Require	ements c	on the Av	ward of Cre	ait Poin	τς						
7	Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)						:: 100%,					
8		t y of the lichtbere										
9	Literatı Siehe je		Ergänzu	ıngsmodul u	ind jewe	eiliges	fachdidaktis	sches Sem	ninar			
10	oder gg Module vorgese	thematis f. auch p e mit 5 Cl ehen sinc natische	oarallel. / P oder m I. Die für	Als Mathem hehr gewähl den M.Ed.N	atische t werde Math jev	Ergän n, die weils	m Fachdidak zung können nicht bereits empfohlener m Semesterl	n grundsät s im Pflich n und im F	tzlich a ntberei -B-Rat	Ille BSc.I ch des L genehm	Math- .aG nigten	

Ehemals:

Mathematische Ergänzung und fachdidaktisches Seminar

Мо	dule nan	ne								
	K mo	dule								
04-	Module no. 04-13- 0002/de Credit Points 8 CP		Workload 240 h	Self-study 240 h	240 h 1 Semest		1 7			
Lan	guage of	Instruct	ion		Person responsib Prof. Dr. phil. nat			ıle		
1	Courses of the Module									
-	Course no. Course name			name	Workload ((-	Form Teach	-	Contact Hours per Week	
2	Study C Siehe T	C ontent eilmodul	e							
3		g Outco eweiliges		Ingsmodul und jewe	eiliges fachdidaktis	ches Semi	inar			
4	-	e ments f eilmodul		cipation						
5	Form o	f Examin	ation							
	Final M	odule Ex	aminatio	on:						
	•	Module	e Examir	ation (Technical Ex	amination, Technic	cal Examin	ation,	Standar	d)	
6	Require	ements o	on the A	ward of Credit Poin	ts					
7	Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)									
8		t y of the lichtbere								
9	Literatu	ure								

	Siehe jeweiliges Ergänzungsmodul und jeweiliges fachdidaktisches Seminar
10	Comment
	Die Mathematische Ergänzung soll jeweils vor dem Fachdidaktischen Seminar absolviert werden oder ggf. auch parallel. Als Mathematische Ergänzung können grundsätzlich alle BSc.Math- Module mit 5 CP oder mehr gewählt werden, die nicht bereits im Pflichtbereich des LaG vorgesehen sind. Die für den M.Ed.Math jeweils empfohlenen und im FB-Rat genehmigten Mathematischen Ergänzungen werden jeweils zum Semesterbeginn per Aushang bekannt gegeben.
	Ehemals: Mathematische Ergänzung und fachdidaktisches Seminar

	Adva	nced Co	ourse in	Optimization					1	
-	dule no.	Credit F	oints	Workload	Self-	study	Duratio	n	Freque	ncy
04-13- 0013/de		18 CP		540 h	1	540 h	1 Semester		Every 2. semester	
	guage of man	Instruct	ion			on responsib liendekan*in				
1	Course	s of the I	Module							
	Course no. Course name			Workload (CP)		Form Teacl	-	Contact Hours per Week		
2	Study C	Content								
2	Modell optima linear p	ing relev lity, poly programs	hedral c ; metho	cs as problems in o ombinatorics. Metl ds for non-linear pi on algorithms, heu	nods: e oblem	exact algorith	ims for ir	nteger		
	Modell optima linear p conditio	ing relev lity, poly programs	hedral c ; metho roximati	ombinatorics. Metl ds for non-linear pi	nods: e oblem	exact algorith	ims for ir	nteger		
	Modell optima linear p conditio	ing relev lity, poly programs ons; app g Outco	hedral c ; metho roximati mes	ombinatorics. Metl ds for non-linear pi	rods: e oblem	exact algorith ns with and w , relaxations	ims for ir vithout bo	iteger oundar	γ	tical
2	Modell optima linear p condition Learnin After ha fundam	ing relev lity, poly programs ons; app g Outco aving att nentals o	hedral c ; metho roximati mes ended tl f discret	ombinatorics. Metl ds for non-linear pr on algorithms, heu ne module, student e and nonlinear op	roblem roblem ristics, s will timiza	exact algorith ns with and w , relaxations have a good tion. The stur	ims for in vithout be commane dents are	nteger oundar d of the	Ύ e theore	
	Modell optima linear p condition Learnin After ha fundam	ing relev lity, poly programs ons; app g Outco aving att nentals o	hedral c ; metho roximati mes ended tl f discret	ombinatorics. Metl ds for non-linear pr on algorithms, heu ne module, student	roblem roblem ristics, s will timiza	exact algorith ns with and w , relaxations have a good tion. The stur	ims for in vithout be commane dents are	nteger oundar d of the	Ύ e theore	
3	Modell optima linear p condition Learnin After ha fundam modelin	ing relev lity, poly programs ons; app g Outco aving att nentals o	hedral c ; metho roximati mes ended tl f discret ems and	ombinatorics. Metl ds for non-linear pr on algorithms, heu ne module, student e and nonlinear op to analyze and app	roblem roblem ristics, s will timiza	exact algorith ns with and w , relaxations have a good tion. The stur	ims for in vithout be commane dents are	nteger oundar d of the	Ύ e theore	
3	Modell optima linear p condition Learnin After ha fundam modelin Require	ing relev lity, poly programs ons; app g Outco aving att nentals o ng proble	hedral c ; metho roximati mes ended th f discret ems and for Partic	ombinatorics. Metl ds for non-linear pr on algorithms, heu ne module, student e and nonlinear op to analyze and app cipation	roblem roblem ristics, s will timiza	exact algorith ns with and w , relaxations have a good tion. The stur	ims for in vithout be commane dents are	nteger oundar d of the	Ύ e theore	
	Modell optima linear p condition Learnin After ha fundam modelin Require Einführ	ing relev lity, poly programs ons; app g Outco aving att nentals o ng proble ements f	hedral c ; metho roximati ended tl f discret ems and or Partic	ombinatorics. Metl ds for non-linear pr on algorithms, heu ne module, student e and nonlinear op to analyze and app cipation	roblem roblem ristics, s will timiza	exact algorith ns with and w , relaxations have a good tion. The stur	ims for in vithout be commane dents are	nteger oundar d of the	Ύ e theore	

	Module Examination (Technical Examination, Technical Examination, Standard)
6	Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, Technical Examination, Weight: 100%, Standard)
8	Usability of the Module Vertiefungsmodul
9	Literature Geiger, Kanzow: Numerische Verfahren zur Lösung unrestringierter Optimierungsaufgaben Nemhauser,Wolsey: Integer and Combinatorial Optimization Nocedial, Wright: Numerical Optimization Schrijver: Theory of Linear and Integer Programming
10	Comment Verantwortlich: Studiendekan

Mo	dule nan	ne									
		tional nbined N		in Mather	natics	and	Subject	Specific	Semi	nar in	Didactics
04-2	dule no. 13- 0/de	Credit F	Points 8 CP	Workload	240 h		study 240 h	Duratio 1 Semes	-	Freque Every 2	ncy . semester
	guage of man	Instruct	ion				on responsib Dr. phil. nat.			ıle	
1	Course	s of the l	Module								
	Course	no.	Course	name			Workload (G	CP)	Form Teach	•.	Contact Hours per Week
2	Siehe Teilmodule										
3		ng Outco eweiliges		ıngsmodul ur	nd jewe	eiliges	fachdidaktis	ches Sem	inar		

4	Requirements for Participation Siehe Teilmodule
5	Form of Examination Final Module Examination:
6	Module Examination (Technical Examination, oral / written Examination, Standard) Requirements on the Award of Credit Points
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module Wahlpflichtbereich, K-Modul
9	Literature Siehe jeweiliges Ergänzungsmodul und jeweiliges fachdidaktisches Seminar
10	Comment

Мо	dule nan	ne									
	Adva	inced C	ourse in	Algebra							
Module no. 04-13- 0103/de		Credit Points 18 CP		Workload 540 h	Self-study 540 h		Duration 1 Semester		Frequency Every 4. semester		
	guage of man	Instruc	tion			on responsib . Dr. rer. nat.					
1	Courses of the Module										
	Course no. Course		name		Workload ((CP)	Form Teach		Contact Hours per Week		
	04-13-0301-vu Advance		d Course in Algebra 1	Course in Algebra 1		0		e and e	0		
	04-13-0302-vu Advanced C			d Course in Algebra 2		0		Lecture Exercis		0	
	04-13-0	303-vu	Advance	d Course in Algebra 3		0		Lecture	e and	0	

		1	1		1
				Exercise	
	04-13-0304-vu	Advanced Course in Algebra 4	0	Lecture and Exercise	0
	04-13-0305-vu	Advanced Course in Algebra 5	0	Lecture and Exercise	0
	04-13-0306-vu	Advanced Course in Algebra 6	0	Lecture and Exercise	0
2	courses with co (2x9 or 1x9+2x algebraic numb	agreed upon between student a omment "recommended: Mathe 5 or 4x5). Typical topics include per theory, algebraic geometry, or algebras, infinite-dimensiona	ematics: Master : arithmetic geor	(alg)" to the extent of netry, automorphic for	18-20 CP
3	 are able to ap have an advanded and a second a seco	ne fundamental principles, notic ply these to typical problems nced understanding of several b view of the relations of these br	ranches of alge anches with eac rledge in these a	bra h other and their place	
4	Requirements Passing "Algeb	for Participation ra"			
5	Form of Exami Final Module E • Modul Fachprüfung: o	xamination: e Examination (Technical Exam	ination, oral Exa	mination, Standard)	
6	Requirements Passing the Fac	on the Award of Credit Points hprüfung			
7	Grading Final Module E • Modul Standa	e Examination (Technical Exam	ination, oral Exa	mination, Weight: 100)%,
8	Usability of the M.Sc. Mathema	e Module atik, M.Sc. Mathematics			
9	Literature cf. e.g. referen - Algebraic Geo	ces to the courses: metry			

10	 Lie Algebras Vertex Algebras Comment Students acquire the agreed upon contents and skills independently, for example by attending

	Adva	nced C	ourse in	Algebra		-						
Module no. 04-13- 0103/en		Credit Points 18 CP		Workload 540 h		Self-study Duration 540 h 1 Seme		Duratior 1 Semes		-	Frequency Every 2. semeste	
					Person responsible for the Module Prof. Dr. rer. nat. Jan Hendrik Bruinier							
L	Courses of the Module											
	Course no.		Course	name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-13-0301-vu		Advance	d Course in Al	gebra 1		0		Lecture Exercis		0	
	04-13-0302-vu		Advance	d Course in Al	gebra 2		0		Lecture Exercis		0	
	04-13-0303-vu Advanc		d Course in Al	gebra 3		0		Lecture Exercis		0		
	04-13-0304-vu Advance		d Course in Al	gebra 4		0		Lecture Exercis		0		
	04-13-0305-vu Advance		d Course in Al	gebra 5		0		Lecture and Exercise		0		
	04-13-03	04-13-0306-vu Advanced Course in Algebra		gebra 6	0		Lecture and C Exercise		0			

hours per week (2x(4+2) or 1x(4+2)+2x(2+1) or 4x(2+1)). Typical topics include: algebraic number theory, algebraic geometry, arithmetic geometry, automorphic forms, spectral theory, operator algebras, infinite-dimensional lie algebras, vertex algebras

3	Learning Outcomes
	Students
	- understand the fundamental principles, notions and methos of the topics chosen
	- are able to apply these to typical problems
	- have an advanced understanding of several branches of algebra
	- have an overview of the relations of these branches with each other and their place within the
	overall context of algebra
	- are able to independently deepen their knowledge in these areas and do guided work on
	research questions in some of these branches
4	Requirements for Participation
	Passing "Algebra"
5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Duration 45 min, Standard)
	Fachprüfung: oral
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	cf. e.g. references to the courses:
	- Algebraic Geometry
	- Arithmetical Geometry I and II
	- Algebraic Number Theory
	 Automorphic Forms Spectral Theory and Operator Algebras
	- Lie Algebras
	- Vertex Algebras
10	Comment
	Students acquire the agreed upon contents and skills independently, for example by attending
	suitable courses or b bookwork. The single topics of this course are not examined speparately

	Adva	nced C	ourse in	Geometry and A	opro	ximation			[
-	dule no.	Credit	Points	Workload	Self	-study	Duratior	on Frequ		iency	
04-13- 0105/de			18 CP	540 h		540 h	1 Semes	ter	Every 6	5. semeste	
.an	guage of	Instruc	tion		Pers	on responsib	le for the	Modu	ıle		
Ser	rman				Prof	. Dr. rer. nat.	Ulrich Re	if			
L	Course	s of the	Module								
	Course no. Course name			name		Workload ((CP)	Form Teach	-	Contact Hours per Week	
	04-13-0501-vu Advanced Course in Geome Approximation 1				y and	0		Lecture Exercis		0	
	04-13-0502-vu Advanced Course in Geome Approximation 2				y and			Lecture and Exercise		0	
	04-13-0503-vu Advanced Course in Geome Approximation 3				y and	0		Lecture Exercis		0	
	04-13-0504-vu Advanced Course in Geome Approximation 4				y and	0		Lecture Exercis		0	
	04-13-0505-vu Advanced Course in Geomet Approximation 6			y and	0		Lecture Exercis		0		
	04-13-0	506-vu	Advance Approxir	d Course in Geometry mation 6	y and	0		Lecture Exercis		0	
2	Study ContentThe topics are agreed upon between student and examiner. Normally these consist of topics of courses with comment "recommended: Mathematics: Master (geo)" to the extent of 18-20 CP (2x9 or 1x9+2x5 or 4x5). Typical topics from either differential or applied geometry and approximation theory include: Riemannian geometry, geometric variational problems; or applied geometry, approximation theory										
	Learning Outcomes Students - understand the fundamental principles, notions and methos of the topics chosen - are able to apply these to typical problems - have an advanced understanding of several branches of geometry and approximation - have an overview of the relations of these branches with each other and their place within the overall context of geometry and approximation - are able to independently deepen their knowledge in these areas and do guided work on										

4	Requirements for Participation
	Passing "Differential Geometry"
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral Examination, Standard)
	Fachprüfung: oral
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	Students acquire the agreed upon contents and skills independently, for example by attending
	suitable courses or b bookwork. The single topics of this course are not examined speparately
	but in one all-encompassing exam.

Мос	dule nan	ne									
	Adva	nced Co	ourse in	Geometry	and A	pprox	imation				
Module no. 04-13- 0105/en		Credit F	Points 18 CP	Workload 540 h		Self-	•	Duration 1 Semester		Frequency Every 6. semester	
Language of Instruction English					Person responsible for the Module Prof. Dr. rer. nat. Ulrich Reif						
1	Course	s of the I	Module								
	Course	no.	Course	name			Workload ((CP)	Form Teacł	•••	Contact Hours per Week
	04-13-0	501-vu	Advance	d Course in G	eometry	y and	0		Lecture	e and	0

	I	1	1	1	1
		Approximation 1		Exercise	
	04-13-0502-vu	Advanced Course in Geometry and Approximation 2	0	Lecture and Exercise	0
	04-13-0503-vu	Advanced Course in Geometry and Approximation 3	0	Lecture and Exercise	0
	04-13-0504-vu	Advanced Course in Geometry and Approximation 4	0	Lecture and Exercise	0
	04-13-0505-vu	Advanced Course in Geometry and Approximation 6	0	Lecture and Exercise	0
	04-13-0506-vu	Advanced Course in Geometry and Approximation 6	0	Lecture and Exercise	0
2	courses with co contact hours p differential or a	agreed upon between student and omment "recommended: Mathem per week (2x(4+2) or 1x(4+2)+2x(2 applied geometry and approximat ometry, geometric variational pro	hatics: Master (geo)" to (+1) or 4x(2+1)). Typication theory include:	o the extent of al topics from e	8+4 either
3	- are able to ap - have an advar - have an overv overall context - are able to inc	omes be fundamental principles, notions ply these to typical problems need understanding of several bra iew of the relations of these bran of geometry and approximation dependently deepen their knowle ons in some of these branches	nches of geometry an ches with each other	d approximation and their place	within the
4	-	for Participation ential Geometry"			
5	Form of Examin Final Module Ex Modul Standar Fachprüfung: o	xamination: e Examination (Technical Examina rd)	ation, oral Examination	n, Duration 45	min,
6	Requirements Passing the Fac	on the Award of Credit Points hprüfung			
7	Grading Final Module Ex Modul Standa	e Examination (Technical Examina	ation, oral Examination	n, Weight: 100'	%,

8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

04-	Module no. 04-13- 0107/de		Points 18 CP			Self	Self-study Dur 540 h 1 Se		Duration L Semester		Frequency Irregular	
	anguage of Instruction German						on responsib . Dr. rer. nat.					
1	Course	s of the	Module									
	Course no.		Course	name	me		Workload (CP)		Form of Teaching		Contact Hours per Week	
			Advance Logic 1	ed Course in Mathematical		0		Lecture and Exercise		0		
	04-13-0702-vu Advance Logic 2			ed Course in Mathematical		0		Lecture and Exercise		0		
	04-13-0	04-13-0703-vu Advance Logic 3		ed Course in Mathematical		0		Lecture and Exercise		0		
	04-13-0	04-13-0704-vu Advand Logic 4		ed Course in Mathematical		0		Lecture and Exercise		0		
	04-13-0	04-13-0705-vu Advanc Logic 5		ed Course in Mathematical		0		Lecture and Exercise		0		
	04-13-0706-vu Advance Logic 6			ed Course in Mathematical		0		Lecture and Exercise		0		
2	Study (Content	<u>.</u>						-		·	
	courses (2x9 or model	The topics are agreed upon between studen courses with comment "recommended: Mat (2x9 or 1x9+2x5 or 4x5). Typical topics includ model theory, proof theory, recursion theor category theory					natics: Master	' (log)" to	the ex	tent of	18-20 CP	

3	Learning Outcomes
	Students - understand the fundamental principles, notions and methos of the topics chosen
	- are able to apply these to typical problems
	- have an advanced understanding of several branches of mathematical logic
	- have an overview of the relations of these branches with each other and their place within the
	overall context of mathematical logic
	- are able to independently deepen their knowledge in these areas and do guided work on
	research questions in some of these branches
4	Requirements for Participation
	Passing "Introduction to Mathematical Logic"
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral Examination, Standard)
	Fachprüfung: oral
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, oral Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	examples of specialised literature include:
	Kohlenbach: Applied Proof Theory: Proof Interpretations and their Use in Mathematics,
	Springer, 2008 Streicher: Domain-Theoretic Foundations of Functional Programming, World Scientific, 2006
	Goranko, Otto: Model Theory of Modal Logics, in: Handbook of Modal Logic, Elsevier, 2007
10	Comment
	Students acquire the agreed upon contents and skills independently, for example by attending
	suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

Мос	dule nam	ne									
		nced Co	ourse in	Mathematical Lo	gic						
ivio 04-1	dule no.	Credit I	Points	Workload	Self	f-study Duration		n Freque		ency	
0107/en		18 CP 540 h			540 h	1 Semest	ter	Every 2	2. semester		
Lang	guage of	Instruct	tion		Pers	son responsib	le for the	Modu	ıle		
Engl						f. Dr. rer. nat.					
1	Course	s of the	Module								
Course no.		Course	name		Workload ((CP)	Form Teach		Contact Hours per Week		
	04-13-0	701-vu	Advance Logic 1	d Course in Mathema	atical	0		Lecture Exercis		0	
	04-13-0		Logic 2				0		e and e	0	
			Logic 3					Lecture and Exercise		0	
04-13-0704-vuAdvanced Course in Mather Logic 404-13-0705-vuAdvanced Course in Mather Logic 5		d Course in Mathema	atical	0		Lecture Exercis		0			
		d Course in Mathema	atical	0		Lecture Exercis		0			
	04-13-0	706-vu	Advance Logic 6	d Course in Mathema	atical	0		Lecture and Exercise		0	
2	Study Content The topics are agreed upon between student and examiner. Normally these consist of topics of courses with comment "recommended: Mathematics: Master (log)" to the extent of 8+4 contact hours per week (2x(4+2) or 1x(4+2)+2x(2+1) or 4x(2+1)). Typical topics include: model theory, proof theory, recursion theory, computability/ complexity, type theory and category theory										
3	Learning Outcomes Students - understand the fundamental principles, notions and methos of the topics chosen - are able to apply these to typical problems - have an advanced understanding of several branches of mathematical logic - have an overview of the relations of these branches with each other and their place within the overall context of mathematical logic - are able to independently deepen their knowledge in these areas and do guided work on research questions in some of these branches										
	researc	h questi	ons in so	me of these branc	hes						

	Passing "Introduction to Mathematical Logic"
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral Examination, Duration 45 min, Standard)
	Fachprüfung: oral
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature examples of specialised literature include: Kohlenbach: Applied Proof Theory: Proof Interpretations and their Use in Mathematics, Springer, 2008 Streicher: Domain-Theoretic Foundations of Functional Programming, World Scientific, 2006 Goranko, Otto: Model Theory of Modal Logics, in: Handbook of Modal Logic, Elsevier, 2007
10	Comment Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

Mod	Module name										
Advanced Course in Numerical Analysis											
Module no. 04-13- 0109/de		• Credit Points 18 CP		Workload 540 h		,		Duration 1 Semester		Frequency Every 4. semester	
Gerr	man					Prof. Dr. rer. nat. Jan Giesselmann					
1	Courses of the Module										
	Course no. Course name					Workload (CP)	Form	of	Contact	

				Teaching	Hours per Week
	04-13-0901-vu	Advanced Course in Numerical Analysis 1	0	Lecture and Exercise	0
	04-13-0902-vu	Advanced Course in Numerical Analysis 2	0	Lecture and Exercise	0
	04-13-0903-vu	Advanced Course in Numerical Analysis 3	0	Lecture and Exercise	0
	04-13-0904-vu	Advanced Course in Numerical Analysis 4	0	Lecture and Exercise	0
	04-13-0905-vu	Advanced Course in Numerical Analysis 5	0	Lecture and Exercise	0
	04-13-0906-vu	Advanced Course in Numerical Analysis 6	0	Lecture and Exercise	0
	courses with co (2x9 or 1x9+2x Numerical met data assimilation	agreed upon between student a omment "recommended: Mathe 5 or 4x5). Typical topics include: hods for partial differential equa on, scalable linear solvers, finite ications in fluid dynamics or solie	matics: Master ations with unce element, finite	(num) ["] to the extent o	of 18-20 CP nethods for
3	- are able to ap - have an adva - have an overv overall context - are able to in	omes ne fundamental principles, notio oply these to typical problems nced understanding of several b view of the relations of these bra c of numerical analysis dependently deepen their know ions in some of these branches	ranches of num anches with eacl	erical analysis h other and their place	
4	-	for Participation erical Analysis of Ordinary Differe	ential Equations	n	
5	Form of Exami Final Module E • Modu Fachprüfung: c	xamination: le Examination (Technical Exami	nation, oral Exa	mination, Standard)	
6	Requirements Passing the Fac	on the Award of Credit Points chprüfung			
7	Grading Final Module E	xamination:			

 Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
Usability of the Module
M.Sc. Mathematik, M.Sc. Mathematics
Literature
Strehmel, Weiner: Numerik gewöhnlicher Differentialgleichungen
Grossmann, Roos: Numerik partieller Differentialgleichungen
Brenan, Campbell, Retzold: Numerical Solution of IVPs in DAEs
LeVeque: Finite Volume Methods for Hyperbolic Problems
Larsson, Thomee: PDE with Numerical Methods
Quarteroni, Valli: Numerical Approximation of PDE
Comment
Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

Mo	dule nan	ne								
	Adva	nced C	ourse in	Numerical Analy	sis					
04-1	Nodule no. D4-13- D109/en		Points 18 CP	Workload 540 h		study 540 h	Duratio 1 Semes	-	Frequ Every	ency 2. semester
Lan	anguage of Instruction					on responsib	le for the	e Modu	ule	
Eng	lish				Prof	. Dr. rer. nat.	Jan Giess	elman	n	
1	Course	s of the	Module							
	Course no. Course		name		Workload ((CP)	Form Teacl	•••	Contact Hours per Week	
	04-13-0	04-13-0901-vu Advance Analysis		d Course in Numerica 1	al	0		Lectur Exercis		0
	04-13-0	902-vu	Advance Analysis	d Course in Numerica 2	al	0		Lectur Exercis		0
	04-13-0	903-vu	Advance Analysis	d Course in Numerica 3	al	0		Lectur Exercis		0
	04-13-0	904-vu	Advance Analysis	d Course in Numerica 4	al	0		Lectur Exercis		0
	04-13-0	905-vu	Advance Analysis	d Course in Numerica 5	al	0		Lectur Exercis		0
	04-13-0	906-vu	Advance Analysis	d Course in Numerica 6	al	0		Lectur Exercis		0

2	Study Content The topics are agreed upon between student and examiner. Normally these consist of topics of
	courses with comment "recommended: Mathematics: Master (num)" to the extent of 8+4 contact hours per week (2x(4+2) or 1x(4+2)+2x(2+1) or 4x(2+1)). Typical topics include: Numerical methods for partial differential equations with uncertain data, efficient methods for data assimilation, scalable linear solvers, finite element, finite volume, or boundary element methods; applications in fluid dynamics or solid mechanics.
3	Learning Outcomes
	Students - understand the fundamental principles, notions and methos of the topics chosen - are able to apply these to typical problems
	- have an advanced understanding of several branches of numerical analysis
	- have an overview of the relations of these branches with each other and their place within the
	overall context of numerical analysis
	 are able to independently deepen their knowledge in these areas and do guided work on research questions in some of these branches
4	Requirements for Participation Passing "Numerical Analysis of Ordinary Differential Equations"
5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Duration 45 min, Standard)
	Fachprüfung: oral
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Strehmel, Weiner: Numerik gewöhnlicher Differentialgleichungen
	Grossmann, Roos: Numerik partieller Differentialgleichungen
	Brenan, Campbell, Retzold: Numerical Solution of IVPs in DAEs LeVeque: Finite Volume Methods for Hyperbolic Problems
	Larsson, Thomee: PDE with Numerical Methods
	Quarteroni, Valli: Numerical Approximation of PDE

10 Comment

Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

Mod	dule nam	ne										
	Adva	nced C	ourse in	Analysis								
04-1	dule no. 13- 1/de	Credit I	Points 18 CP			lf-study 540 h	Duration 1 Semester		Frequency Every 4. semester			
Lan Geri	guage of man	Instruct	tion		Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber							
1	Course	Courses of the Module										
	Course	no.	Course	name		Workload (CP)	Form Teach	-	Contact Hours per Week		
	04-13-1101-vu		Advance	d Course in Analysis 1	L	0		Lectur Exercis		0		
	04-13-1102-vu A		Advance	d Course in Analysis 2	2	0		Lectur Exercis		0		
	04-13-1103-vu		Advance	d Course in Analysis 3	}	0		Lectur Exercis		0		
	04-13-1104-vu Advance		d Course in Analysis 4	ļ	0		Lectur Exercis		0			
	04-13-1105-vu Advanc		Advance	d Course in Analysis 5	5	0		Lectur Exercis		0		
	04-13-1	04-13-1106-vu Advanced 0		d Course in Analysis 6	5	0		Lectur Exercis		0		
2	Study C	Content	•					•		<u> </u>		
The topics are agreed upon between student and examiner. Normally these consist of topics courses with comment "recommended: Mathematics: Master (ana)" to the extent of 18-20 ((2x9 or 1x9+2x5 or 4x5). Typical topics include: Investigation of existence, uniqueness and regularity of linear and nonlinear partial different equations with modern methods and focus on elliptic, parabolic or hyperbolic equations with applications e.g. in fluid mechanics or materials science.									18-20 CP ifferential			
3	Studen - under - are ab	stand th lle to ap	e fundar ply these	nental principles, no to typical problems erstanding of severa	S			opics ch	nosen			

	1
	- have an overview of the relations of these branches with each other and their place within the
	overall context of analysis
	- are able to independently deepen their knowledge in these areas and do guided work on
	research questions in some of these branches
4	Requirements for Participation
	depending on the topics covered
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral Examination, Standard)
	Fachprüfung: oral
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	Gilbarg, Trudinger: Elliptic Partial Differential Equations of Second Order;
	Amann: Linear and Quasilinear Parabolic Problems;
	Dafermos: Hyperbolic Conservation Laws in Continuum Physics;
	Galdi: An Introduction to the Theory of the Navier-Stokes Equations;
10	Comment
	Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

Module nam	Module name											
Adva	Advanced Course in Analysis											
Module no. 04-13- 0111/en	Credit Points 18 CP	Workload	540 h	Self-study	Frequency Every 2. semester							
Language of	Instruction			Person responsible for the Module								

Eng	lish		Prof. Dr. rer. nat. Mat	thias Hieber						
1	Courses of the	Module								
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week					
	04-13-1101-vu	Advanced Course in Analysis 1	0	Lecture and Exercise	0					
	04-13-1102-vu	Advanced Course in Analysis 2	0	Lecture and Exercise	0					
	04-13-1103-vu	Advanced Course in Analysis 3	0	Lecture and Exercise	0					
	04-13-1104-vu	Advanced Course in Analysis 4	0	Lecture and Exercise	0					
	04-13-1105-vu	Advanced Course in Analysis 5	0	Lecture and Exercise	0					
	04-13-1106-vu	Advanced Course in Analysis 6	0	Lecture and Exercise	0					
	Investigation of existence, uniqueness and regularity of linear and nonlinear partial differential equations with modern methods and focus on elliptic, parabolic or hyperbolic equations with applications e.g. in fluid mechanics or materials science.									
3	- are able to ap - have an advar - have an overv overall context - are able to inc	ne fundamental principles, no oply these to typical problems nced understanding of severa view of the relations of these	l branches of analysis branches with each ot owledge in these areas	her and their plac						
4	-	for Participation the topics covered								
5	Form of Exami Final Module E • Modu Standa	xamination: le Examination (Technical Exa	mination, oral Examin	ation, Duration 45	min,					

6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Gilbarg, Trudinger: Elliptic Partial Differential Equations of Second Order; Amann: Linear and Quasilinear Parabolic Problems; Dafermos: Hyperbolic Conservation Laws in Continuum Physics; Galdi: An Introduction to the Theory of the Navier-Stokes Equations;
10	Comment Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

Мос	dule nam	ne								
	Adva	nced C	ourse in	Optimization						
04-1	Module no. 04-13- 0113/de		Points 18 CP	Workload 540 h		study 540 h	Duration 1 Semester		Frequency Every 4. semester	
	Language of Instruction German					on responsib . Dr. rer. nat.			ıle	
1	Courses of the Module									
	Course no. Course		name		Workload ((CP)	Form Teach		Contact Hours per Week	
	04-13-1301-vu Advance			d Course in Optimiza	tion	0		Lecture Exercis		0
	04-13-1	302-vu	Advance 2	d Course in Optimiza	tion	0		Lecture Exercis		0
	04-13-1	303-vu	Advance 3	d Course in Optimiza	tion	0		Lecture Exercis		0
	04-13-1304-vu Advance 4			d Course in Optimiza	tion	0		Lecture Exercis		0

	04-13-1305-vu	Advanced Course in Optimization	0	Lecture and	0					
	04-13-1306-vu	5 Advanced Course in Optimization	0	Exercise Lecture and	0					
		6		Exercise						
2	courses with co (2x9 or 1x9+2x	agreed upon between student an omment "recommended: Mathen 5 or 4x5). Typical topics include: nization; discrete optimization	-		•					
3	 are able to ap have an advanded have an overvolution overall context are able to ind 	ne fundamental principles, notion oply these to typical problems need understanding of several bra- view of the relations of these bra- of optimization dependently deepen their knowle ions in some of these branches	anches of optimization nches with each other	and their place						
4	Requirements for Participation Passing "Introduction to Optimization"									
5	Form of Exami Final Module E • Modul Fachprüfung: o	xamination: le Examination (Technical Examin	ation, oral Examinatio	n, Standard)						
6	Requirements Passing the Fac	on the Award of Credit Points								
7	Grading Final Module E • Modul Standa	le Examination (Technical Examin	ation, oral Examinatio	n, Weight: 100	%,					
8	Usability of the M.Sc. Mathem	e Module atik, M.Sc. Mathematics								
9	Literature depending on t	copic								
10		re the agreed upon contents and s or b bookwork. The single topic		• •	-					

	Adva	nced C	ourse in	Optimization					1			
	dule no.	Credit	Points	Workload	Self	-study	Duratio	n	Freque	ency		
	13- L3/en		18 CP 540 h			540 h	1 Semes	ter	Every 2	2. semester		
	iguage of	Instruc	tion	I	Person responsible for the Module							
Eng	glish				Prof. Dr. rer. nat. Stefan Ulbrich							
1	Course	s of the	Module									
	Course no.		Course	name		Workload (CP) Form of Teaching		-	Contact Hours per Week			
	04-13-1	301-vu	Advance 1	d Course in Optimizat	tion	0		Lectur Exercis		0		
	04-13-1	04-13-1302-vu Advanced Course in Optimizatio			tion	0	Lecture and Exercise		0			
	04-13-1	Advanced Course in Optimizatio		tion	0		Lectur Exercis		0			
	04-13-1304-vu Advanced (4		d Course in Optimizat	tion	0		Lectur Exercis		0			
	04-13-1305-vu Advanc 5			d Course in Optimizat	tion	0		Lectur Exercis		0		
	04-13-1	306-vu	Advance 6	d Course in Optimizat	tion	0		Lectur Exercis		0		
2	Study C	Study Content										
	The topics are agreed upon between student and examiner. Normally these consist of topics of courses with comment "recommended: Mathematics: Master (opt)" to the extent of 8+4 contact hours per week ($2x(4+2)$ or $1x(4+2)+2x(2+1)$ or $4x(2+1)$). Typical topics include: nonlinear optimization; discrete optimization											
3	Studen - under - are ab - have a - have a overall	Learning Outcomes Students - understand the fundamental principles, notions and methos of the topics chosen - are able to apply these to typical problems - have an advanced understanding of several branches of optimization - have an overview of the relations of these branches with each other and their place within the overall context of optimization - are able to independently deepen their knowledge in these areas and do guided work on										

4	Requirements for Participation
	Passing "Introduction to Optimization"
5	Form of Examination
	Final Module Examination:
	Module Examination (Technical Examination, oral Examination, Duration 45 min,
	Standard)
	Fachprüfung: oral
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
′	Final Module Examination:
	Module Eventingtion (Technical Eventingtion, and Eventingtion, Maight, 100%
	 Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately
	but in one all-encompassing exam.

Mo	dule nan	ne									
	Adva	inced Co	ourse in	Stochastic	S						
Module no. 04-13- 0115/de		Credit F	Points 18 CP	Workload	540 h	Self-st	•	Duration 1 Semester		Frequency Every 2. semeste	
	guage of man	Instruct	ion				n responsib Dr. rer. nat.				
1	Course	s of the	Module								
Course		no.	Course	name		ľ	Workload ((CP)	Form Teacl	•••	Contact Hours per Week

	04-13-1501-vu	Advanced Course in Stochastics 1	0	Lecture and Exercise	0		
	04-13-1502-vu	Advanced Course in Stochastics 2	0	Lecture and Exercise	0		
	04-13-1503-vu	Exercise					
	04-13-1504-vu						
	04-13-1505-vu	Advanced Course in Stochastics 5	0	Lecture and Exercise	nd 0		
	04-13-1506-vu	Advanced Course in Stochastics 6	0	Lecture and Exercise	0		
	courses with co (2x9 or 1x9+2x	agreed upon between student an omment "recommended: Mather 5 or 4x5). Typical topics include: statistics, curve estimation, stoch	natics: Master (sto)" to	o the extent of	18-20 CP		
3	 are able to ap have an advar have an overvoverall context are able to ind 	ne fundamental principles, notion ply these to typical problems nced understanding of several bra view of the relations of these bra	anches of stochastics nches with each other	and their place			
4	Requirements Passing "Proba	for Participation bility Theory"					
5	Form of Examin Final Module E Modul Fachprüfung: o	xamination: e Examination (Technical Examin	ation, oral Examinatio	n, Standard)			
6	Requirements Passing the Fac	on the Award of Credit Points hprüfung					
7	Grading Final Module E	xamination:					
	• Modul Standa	e Examination (Technical Examin rd)	ation, oral Examinatio	n, Weight: 100)%,		

8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Beispielhaft seien genannt: Pestmann: Mathematical Statistics Karatzas, Shreve: Brownian Motion and Stochastic Calculus Bain, Crisone: Fondamentals of Stochastic Filtering Da Brato, Zabczyk: Stochastic Equation in finite Arguments Györfi, Kohler, Krzyzak, Walk: A distribution-free theory of nonparametric regression.
10	Comment Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately but in one all-encompassing exam.

	Advar	nced C	ourse in	Stochastics	1					
Module no. 04-13- 0115/en		edit Points Workload 18 CP 540 h			-study 540 h	Duratior 1 Semes			e ncy 5. semester	
Langu	age of I	nstruct	tion		Pers	son responsib	le for the	Modu	ıle	
Englisł	h				Prof	f. Dr. rer. nat.	Michael I	Kohler		
1 C	Courses	of the	Module							
С	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
0	04-13-1501-vu Advance		Advance	d Course in Stochast	0		Lecture and Exercise		0	
0	04-13-1502-vu Advance		Advance	ed Course in Stochastics 2		0		Lecture and Exercise		0
0	4-13-15	03-vu	Advance	d Course in Stochast	0		Lecture and Exercise		0	
0	4-13-15	04-vu	Advance	ed Course in Stochastics 4		0		Lecture and Exercise		0
0	04-13-1505-vu Advanc		Advance	ed Course in Stochastics 5		0		Lecture and Exercise		0
	4-13-15	06-vu	Advance	d Course in Stochast	ics 6	0		Lecture		0

	hours per week (2x(4+2) or 1x(4+2)+2x(2+1) or 4x(2+1)). Typical topics include: mathematical statistics, curve estimation, stochastic processes, stochastic (partial) differential equations
3	Learning Outcomes Students - understand the fundamental principles, notions and methos of the topics chosen - are able to apply these to typical problems - have an advanced understanding of several branches of stochastics - have an overview of the relations of these branches with each other and their place within the overall context of stochastics - are able to independently deepen their knowledge in these areas and do guided work on research questions in some of these branches
4	Requirements for Participation Passing "Probability Theory"
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral Examination, Duration 45 min, Standard) Fachprüfung: oral
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature Beispielhaft seien genannt: Pestmann: Mathematical Statistics Karatzas, Shreve: Brownian Motion and Stochastic Calculus Bain, Crisone: Fondamentals of Stochastic Filtering Da Brato, Zabczyk: Stochastic Equation in finite Arguments Györfi, Kohler, Krzyzak, Walk: A distribution-free theory of nonparametric regression.
10	Comment Students acquire the agreed upon contents and skills independently, for example by attending suitable courses or b bookwork. The single topics of this course are not examined speparately

but in one all-encompassing exam.

Mo	dule nam	ne									
				atics (alg), Ma	astei					[
	Module no. Credit Points Workload			50 h	Self-	study	Duratio		Freque	-	
	13-0139		5 CP	1	50 h	_		1 Semes		· ·	2. semester
	guage of		ion				on responsib iendekan*in				
	man and	_				Stud	iendekan*in	des Fach	bereici	15 04	
1	Courses	s of the l						_			
	Course	no.	Course	name			Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-02	203-se	Seminar Master	in Mathematics	(alg),		0		Semina	ar	2
2	Details	ing on to of the so	hedule a	and topics can l	be ot	otaine	d from the le	ecturer.			
3	Student - give at - learn a	advance	to Id writte d-level m	n presentation nathematical m discussions ab	nateri	ial on	their own				natical talk
4	-		or Partio dependi	c ipation ng on topic							
5		f Examir Examina	ition:								
	 [04-00-0203-se] (Study Examination, Presentation, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar) 										
6	-			ward of Credit ung	Poin	ts					
7	Passing the Studienleistung Grading Course Examination:										

	• [04-00-0203-se] (Study Examination, Presentation, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Master (alg)

Mo	dule nam	-								
Mo	Semi dule no.			atics (ana), Maste Workload		-study	Duratio	n	Freque	ency
-	13-0140	creater	5 CP	150 h	Jen	•	1 Semes		-	2. semester
Lan	guage of	Instruct	tion		Pers	son responsib	le for th	e Modu	ule	
Ger	man and	English			Stud	diendekan*in	des Fach	bereicł	ns 04	
1	Course	s of the	Module							
	Course no. Co		Course	name		Workload ((CP)	Form Teach		Contact Hours per Week
	04-00-0	204-se	Seminar Master	in Mathematics (ana)	,	0		Semina	ar	2
		ling on t of the so	•	and topics can be ob	otain	ed from the le	ecturer.			
3		g Outco ts learn								
	Ū			n presentation of a			nathema	tical to	pic	
				nathematical materi discussions about t			esentatic	on of a	mathen	natical talk
4	Requirements for Participation recommended: depending on topic									
5		f Exami r Examina								
	•	[04-00	-0204-se] (Study Examinatio	n, Sp	ecial Form, P	assed / N	lot Pas	sed)	

	Studienleistung: Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar)
6	Requirements on the Award of Credit Points Passing the Studienleistung
7	 Grading Course Examination: [04-00-0204-se] (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (ana)

IVIO	dule nam										
	Semi	nar in N	Nathem	atics (geo),	Maste	er					
Мо	dule no.	Credit I	Points	Workload		Self-	study	Duration	า	Freque	ency
04-:	13-0141		5 CP		150 h		120 h	1 Semes	ter	Every	2. semester
Lan	guage of	Instruct	tion			Pers	on responsib	le for the	e Modu	ule	
Ger	man and	English				Stud	iendekan*in	des Fachl	bereicl	าร 04	
1	Courses	s of the	Module			•					
	Course no.		Course name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-02	205-se	Seminar Master	r in Mathematics (geo),		, 0			Semina	ar	2
2	Study C depend Details	ing on t	•	and topics car	n be ol	otaine	d from the le	ecturer.			
 3 Learning Outcomes Students learn to - give an oral and written presentation of an advanced-level mathematical topic - learn advanced-level mathematical material on their own 											

	- engage in professional discussions about the content and presentation of a mathematical talk
4	Requirements for Participation
	recommended: depending on topic
5	Form of Examination
	Course Examination:
	• [04-00-0205-se] (Study Examination, Special Form, Passed / Not Passed)
	Studienleistung: Oral presentation, written expose where appropriate (Details will be
	announced at the beginning of the seminar)
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Course Examination:
	• [04-00-0205-se] (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Master (geo)

Мос	Module name										
	Seminar in Mathematics (log), Master										
Module no. Credit Points Workload Self-study Duration Frequency									ncy		
04-13-0142 5 CP 150 h 120 h 1 Semester Every 2. s						semester					
Language of Instruction German and English 1 Courses of the Module						Person responsible for the Module Studiendekan*in des Fachbereichs 04					
	Course no. Course name					Workload ((CP)	Form Teach	•.	Contact Hours per Week	
	04-00-02	206-se	Seminar Master	in Mathemat	ics (log),		0		Semina	ar	2

2	Study Content
	depending on topic
	Details of the schedule and topics can be obtained from the lecturer.
3	Learning Outcomes
	Students learn to
	- give an oral and written presentation of an advanced-level mathematical topic
	- learn advanced-level mathematical material on their own
	- engage in professional discussions about the content and presentation of a mathematical talk
4	Requirements for Participation
	recommended: depending on topic
5	Form of Examination
	Course Examination:
	• [04-00-0206-se] (Study Examination, Special Form, Passed / Not Passed)
	Studienleistung: Oral presentation, written expose where appropriate (Details will be
	announced at the beginning of the seminar)
6	Requirements on the Award of Credit Points
	Passing the Studienleistung
7	Grading
	Course Examination:
	• [04-00-0206-se] (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	M.Sc. Mathematik, M.Sc. Mathematics
9	Literature
	depending on topic
10	Comment
	recommended: Mathematics: Master (log)

Module name								
Seminar in Mathematics (num), Master								
Module no.	Credit Points	Workload		Self-study	Duration	Frequency		
04-13-0143	5 CP		150 h	120 h	1 Semester	Every 2. semester		
Language of	Instruction			Person responsible for the Module				

Geri	man and English		Studiendekan*in des Fa	chbereichs 04							
1	Courses of the	Module	Ι								
	Course no. Course name		Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-00-0207-se	Seminar in Mathematics (nun Master	n), 0	Seminar	2						
2	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer.										
3	Learning Outcomes Students learn to - give an oral and written presentation of an advanced-level mathematical topic - learn advanced-level mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk Requirements for Participation										
	recommended: depending on topic										
5	 Form of Examination Course Examination: [04-00-0207-se] (Study Examination, Special Form, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate (Details will be announced at the beginning of the seminar) 										
6	Requirements on the Award of Credit Points Passing the Studienleistung										
7	Grading Course Examination: • [04-00-0207-se] (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)										
8	Usability of the M.Sc. Mathema	e Module atik, M.Sc. Mathematics									
9	Literature depending on t	opic									
10	Comment recommended:	Mathematics: Master (num))								

1410	dule nan Semi		Лathem	atics (opt), M	laste	r					
Мо	dule no.			Workload			study	Duratio	Duration		ncy
04-	04-13-0144 5 CP 150				.50 h		120 h	1 Semes	ter	Every 2	. semester
Lan	guage of	Instruct	ion			Pers	on responsib	le for the	e Modu	ule	
Ger	man and	English				Stud	iendekan*in	des Fach	bereich	ns 04	
1	Courses of the Module										
	Course	no.	Course	name			Workload ((CP)	Form Teach		Contact Hours per Week
	04-00-0208-se Seminar in Mathematics Master					,	0		Semina	ar	2
2	Study Content depending on topic Details of the schedule and topics can be obtained from the lecturer.										
4	Students learn to - give an oral and written presentation of an advanced-level mathematical topic - learn advanced-level mathematical material on their own - engage in professional discussions about the content and presentation of a mathematical talk Requirements for Participation										
	-			ng on topic							
5		f Examir Examina	ation:								
• [04-00-0208-se] (Study Examination, Special Form, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate (Details will announced at the beginning of the seminar)							-				
6	-		on the A dienleist	ward of Credit ung	Poin	ts					
7	Grading Course Examination: • [04-00-0208-se] (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)										

8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (opt)

Mo	dule nam	ne								
	Semi	nar in N	/lathem	atics (sto), Maste	er					
Mo	dule no.	Credit P	oints	Workload	Self	-study	Duratio	n	Freque	ency
04-2	04-13-0145 5 CP 150				l	120 h	1 Semes	ster	Every	2. semester
Lan	guage of	Instruct	ion		Pers	on responsib	le for th	e Modu	ule	
Ger	man and	English			Stud	liendekan*in	des Fach	bereicł	ns 04	
1	Course	s of the I	Module							
	Course no.		Course	name		Workload ((CP)	Form Teacł		Contact Hours per Week
	04-00-0	209-se	Seminar Master	in Mathematics (sto),	0 Seminar				2
2	Study Content depending on topic									
3	Student - give a - learn a	advance	o d writte d-level m	n presentation of a nathematical mate discussions about	rial on	their own				natical talk
4	-		or Partic dependi	cipation ing on topic						
5	Form of Examination Course Examination: • [04-00-0209-se] (Study Examination, Special Form, Passed / Not Passed) Studienleistung: Oral presentation, written expose where appropriate (Details will be									

6	Requirements on the Award of Credit Points Passing the Studienleistung
7	 Grading Course Examination: [04-00-0209-se] (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module M.Sc. Mathematik, M.Sc. Mathematics
9	Literature depending on topic
10	Comment recommended: Mathematics: Master (sto)

Мос	dule nan	ne									
	Adva	nced C	ourse N	umerical Anal	ysis	Data	Science				
Module no. 04-13- 0209/en		Credit Points 18 CP		Workload 54	40 h		study 540 h	Duration 1 Semester		Frequency Every semester	
	L anguage of Instruction English						on responsib . Dr. rer. nat.				
1	Course	s of the	Module								
	Course no.		Course	name			Workload (CP) Form Teach		•••	Contact Hours per Week	
				d Course Numer Data Science 1	ical		0		Lectur Exercis		0
	04-13-2	092-vu		d Course Numer Data Science 2	ical		0		Lectur Exercis		0
	04-13-2	093-vu		d Course Numer Data Science 3	ical		0		Lecture and Exercise		0
	04-13-2			d Course Numer Data Science 4	ical		0		Lectur Exercis		0
				d Course Numer Data Science 5	ical		0		Lectur Exercis		0
	04-13-2096-vu			d Course Numer Data Science 6	ical		0		Lectur Exercis	0 00	0
2	Study C	Content	•								•

	The topics are agreed upon between student and examiner. Normally these consist of topics of courses with comment "Mathematics: Master (Mathematics in Data Science num)" to the extent of 8+4 contact hours per week $(2x(4+2) \text{ or } 1x(4+2)+2x(2+1) \text{ or } 4x(2+1)$. Typical topics include numerical methods for partial differential equations with uncertain data, efficient methods for data assimilation and scalable linear solvers for data science.
3	Learning Outcomes The students know and understand the concepts, methods and results that have been covered in the lecture and they are able to employ them. The students have a in-depth understanding of several areas of numerical analysis and scientific computing. They understand how the topics are related and how they fit into the general context of numerical analysis and scientific computing. They are able to independently extend their knowledge and to pursue research questions in certain areas with proper guidance
4	Requirements for Participation Recommended: Numerik gewöhnlicher Differentialgleichungen
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, oral Examination, Duration 45 min, Standard)
6	Requirements on the Award of Credit Points Passing the Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	Usability of the Module M. Sc. Mathematics, Mathematics in Data Science
9	Literature M. Asch, M. Bocquet, M. Nodet; Data Assimilation: Methods, Algorithms and Applications, SIAM 2016 S. Brenner, R. Scott: Mathematical Theory of Finite Element Methods, Texts in Applied Mathematics, Vol. 15, Springer, 2008 W. Hackbusch, Iterative Solution of Large Sparse Systems of Equations, 2nd ed. 2016, Applied Mathematical Sciences Vol. 95, Springer International Publishing, 2016 S. Larsson, V. Thomée: Partial Differential Equations with Numerical Methods. Texts in Applied Mathematics, Vol. 45, Springer 2003. K. Law, A. Stuart, Konstantinos Zygalakis; Data Assimilation: A mathematical introduction, Springer, 2015 G. J. Lord, C. E. Powell, and T. Shardlow. An Introduction to Computational Stochastic PDEs. Cambridge University Press, 2014.

10 Comment

Die vereinbarten Inhalte und Kompetenzen erwirbt der/die Studierende eigenständig, z.B. durch Teilnahme an Lehrveranstaltungen entsprechenden Inhalts oder im Selbststudium. Die einzelnen Inhalte des Vertiefungsmoduls Numerik und Wissenschaftliches Rechnen werden nicht separat, sondern in einem alle Inhalte umfassenden Prüfungsereignis geprüft

		ncea C	ourse A	nalysis Data Scien	ce					
Module no. 04-13- 0211/en		Credit		Workload	Self	-study	Duratio		Freque	•
			18 CP	540 h		540 h	1 Semes	ster	Every	semester
	iguage of glish	Instruc	tion			son responsib f. Dr. rer. nat.			ıle	
1	Course	s of the	Module							
	Course	no.	Course	name		Workload ((CP)	Form Teacł	-	Contact Hours per Week
	04-13-2111-vu Advar Science			d Course Analysis Dat 1	ta	0		Lecture Exercis		0
	04-13-2112-vu Advan Scienc			d Course Analysis Dat 2	ta	0		Lecture Exercis		0
			Advance Science	d Course Analysis Dat 3	ta	0		Lecture Exercis		0
			Advance Science	d Course Analysis Dat 4	ta	0		Lecture Exercis		0
	04-13-2	115-vu	Advance Science	d Course Analysis Dat 5	ta	0		Lecture Exercis		0
	04-13-2	116-vu	Advance Science	d Course Analysis Dat 5	ta	0	Lecture and Exercise		0	
2	Study Content he topics are agreed upon between student and examiner. Normally these consist of topics of courses with comment "recommended: Mathematics: Master (ana)" to the extent of of 8+4 contact hours per week (2x(4+2) or 1x(4+2)+2x(2+1) or 4x(2+1)) Typical topics include: Investigation of existence, uniqueness and regularity of linear and nonlinear partial differential equations with modern methods, applications in fluid mechanics using data science driven methods.									

	- understand the fundamental principles, notions and methos of the topics chosen
	- are able to apply these to typical problems
	- have an advanced understanding of several branches of analysis
	- have an overview of the relations of these branches with each other and their
	place within the overall context of analysis and data science
	- are able to independently deepen their knowledge in these areas and do
	guided work on research questions in some of these branches
4	Requirements for Participation
	depending on the topics covered
5	Form of Examination
-	Final Module Examination:
	Module Examination (Technical Examination, oral Examination, Duration 40 min,
	Standard)
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, oral Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	M. Sc. Mathematics, Mathematics in Data Science
9	Literature
	L.C. Evans: Partial Differential Equations (AMS)
	TP. Tsai: Lectures on Navier-Stokes Equations (AMS)
	M. Tucsnak, G. Weiss: Observation and Control for Operator Semigroups (Springer)
	S. Reich, C. Cotter: Probabilistic Forecasting and Bayesian Data Assimilation
	(Cambrige University Press)
	Moukalled, F., Mangani, L., amp; Darwish, M. (2016). The finite volume method. In
	The finite volume method in computational fluid dynamics (pp. 103-135).
	Springer, Cham.
	Maric, Tomislav, Jens Hopken, and Kyle Mooney. "The OpenFOAM technology
	primer." (2014). Karniadakis G. E. Kovrekidis J. G. Lu, L. Perdikaris P. Wang S. amp: Yang J.
	Karniadakis, G. E., Kevrekidis, I. G., Lu, L., Perdikaris, P., Wang, S., amp; Yang, L. (2021). Physics-informed machine learning. Nature Reviews Physics, 3(6),
	422-440.
10	Comment

		nced C	ourse O	ptimization Data S	Scien	се			[
Module no. 04-13-		Points	Workload	Self-	study	Duratior	า	Freque	ency	
0213/en		18 CP	540 h		540 h	1 Semes	ter	Every	semester	
an	guage of	Instruc	tion		Pers	on responsib	le for the	e Modu	le	
Eng	lish				Prof.	Dr. rer. nat.	Marc Pfe	tsch		
1	Courses of the Module							1		
	Course	no.	Course	name		Workload (CP)			of ning	Contact Hours per Week
	04-13-2	131-vu	Advance Data Scie	d Course Optimizatio ence 1	n	0		Lectur Exercis		0
	04-13-2	04-13-2132-vu Advanced Course Optimizat Data Science 2 04-13-2133-vu Advanced Course Optimizat Data Science 3			n	E E			Lecture and Exercise	
	04-13-2				n				Lecture and Exercise	
	04-13-2	4-13-2134-vu Advanced Course Optimizat Data Science 4		•	n				Lecture and Exercise	
	04-13-2135-vu Advanced Co Data Science			d Course Optimizatio ence 5	n	0		Lectur Exercis		0
	04-13-2	136-vu	Advance Data Scie	d Course Optimizatio ence 6	n	0		Lecture and Exercise		0
2	Study ContentThe topics are agreed upon between student and examiner. Normally these consist of topics of courses with comment "recommended: Mathematics: Master (Optimization Data Science)" to the extent of 8+4 contact hours per week (2x(4+2) or 1x(4+2)+2x(2+1) or 4x(2+1).Typical topics include: Theory: conditions for optimality, polyhedral combinatorics. Methods: exact algorithms for integer linear programs; methods for non-linear problems with and without boundary conditions; approximation algorithms, heuristics, relaxations									
3	Learning Outcomes After having attended the module, students will have a good command of the theoretical fundamentals of discrete and nonlinear optimization. The students are additionally able to solve modeling problems and to analyze and apply relevant algorithms.									

5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Duration 45 min, Standard)
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung
7	Grading
	Final Module Examination:
	Module Examination (Technical Examination, eral Examination, Weight: 100%)
	 Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
	Standardy
8	Usability of the Module
	M. Sc. Mathematics, Mathematics in Data Science
9	Literature
	Geiger, Kanzow: Numerische Verfahren zur Lösung unrestringierter Optimierungsaufgaben
	Nemhauser, Wolsey: Integer and Combinatorial Optimization
	Nocedial, Wright: Numerical Optimization Schrijver: Theory of Linear and
	Integer Programming
10	Comment

Mo	dule nan	ne								
	Adva	nced C	ourse St	ochastics Data	Scien	e				
04-1	dule no. 13- 5/en	Credit I	Points 18 CP	Workload 54	0 h	f-study 540 h	Duratio 1 Semes		Freque Every s	e ncy semester
Lan Eng	guage of lish	Instruc	tion			rson responsil of. Dr. rer. nat.			ıle	
1	Course	s of the	Module							
	Course no. Course		name		Workload (CP)	Form of Teaching		Contact Hours per Week	
	04-13-2	3-2151-vu Advance Science		ed Course Stochastics Data 1		0	0		e and e	0
	04-13-2152-vu Advance Science				0		Lecture and Exercise		0	

	1				
	04-13-2153-vu	Advanced Course Stochastics Data Science 3	0	Lecture and Exercise	0
	04-13-2154-vu	Advanced Course Stochastics Data Science 4	0	Lecture and Exercise	0
	04-13-2155-vu	Advanced Course Stochastics Data Science 5	0	Lecture and Exercise	0
	04-13-2156-vu	Advanced Course Stochastics Data Science 6	0	Lecture and Exercise	0
2		this modul consists of the conten theory for Deep Learning".	ts of the two modules	"Mathematica	al Statistics"
3	mentioned abc Learning and a	omes now and understand the concept ove. They have a deep understand re able to learn new knowledge ir for Participation	ing of Mathematical S	tatistics and D	
5	Form of Exami Final Module E • Modul Standa	xamination: le Examination (Technical Examination)	ation, oral Examinatio	n, Duration 45	min,
6	Requirements Passing the Fac	on the Award of Credit Points			
7	Grading Final Module E • Modul Standa	le Examination (Technical Examination	ation, oral Examinatio	n, Weight: 100	%,
8	Usability of the M. Sc. Mathem	e Module natics, Mathematics in Data Scienc	ce		
9	Devroye, Lugos Goodfellow, Be	aano: Testing Statistical Hypothese si: Combinatorial methods in dens engio, Courville: Deep Learning. Krzyzak, Walk: A distribution - fre	ity estimation	etric regressio	n
10	Comment				

	Math	ematic	s as Cor	nmon Language ii	n Science					
Module no. 04-14- 0001/de		Credit F	Points Workload 5 CP 15		Self-study 105 h	Duration 1 Semester		Frequency Every 2. semester		
	iguage of	Instruct	ion		Person responsil	le for the l	Modu	le		
Ger	rman				Prof. Dr. rer. nat. Burkhard Kümmerer					
1		s of the l								
	Course	no.	Course	name	Workload (-	Form (Teachi	-	Contact Hours per Week	
	04-14-0	001-vu		artics as Common e in Science	0		Lecture Exercise		3	
	In an in	the sign		multidisciplinary re and functionality of						

	7	
	Mather	matical Reflections:
	•	All is number: blessing and curse of quantifying
	•	On the use of formulas: What you put into it and what you get out.
	•	Mathematical models of reality: capabilities and limitations
	•	On the truth of mathematics
	•	Historical remarks on mathematics as a language for natural sciences
	•	Mathematics is a very special language: Axioms, definitions, and proofs inside and outside of mathematics
	•	The abstractness of mathematics as a condition for its universal applicability
	concen	ding on the target group, the support classes address students of mathematics, trating, amongst other things, on specialist aspects of mathematics; students who do not nathematics are tutored in the fundamentals of handling mathematical language in its
3	Learnin	ng Outcomes
	Studen	ts are able to
	•	apply fundamental mathematical methods in natural sciences
	•	read and to understand mathematical texts and to interpret mathematical formulas
	•	apply the addressed mathematical methods successfully
	•	mathematize scientific issues and to describe quantitative relations by formulas
	•	compare and to critically question mathematical models
	•	see relations between various naturals sciences
	•	support their school lessons by interdisciplinary cross linking
	•	state the role of mathematics for natural sciences
	•	explain the relation between abstract mathematics and concrete applications
	•	explain the relation between abstract mathematics and concrete applications resort to important concepts from the history if ideas and from the philosophy of science

4	Requirements for Participation
	none
5	Form of Examination Final Module Examination:
	Module Examination (Technical Examination, oral / written Examination, Standard)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
	Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung (normally the exam is held orally; in case of a large number of participants the exam can be held as a written test)
7	Grading Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Teaching degrees: Vernetzungsbereich
9	Literature Georg Glaeser: Der mathematische Werkzeugkasten. Anwendungen in Natur und Technik. Springer Spektrum.
	Tilo Arens et al.: Mathematik. Springer Spektrum.
10	Comment

Module nam	ne				
Proje	ect in Mathema	tical Consulting			
Module no.	Credit Points	Workload	Self-study	Duration	Frequency

04-14	4-0100		2 CP	60 h		30 h	1 Semest	ter	Every 2	. semester
Langu	uage of	Instruct	tion			on responsib				
Germ					Prof	. Dr. rer. nat.	Jan Giess	elman	n	
1	Courses	s of the	Module			T		1		
	Course no.		e no. Course name			Workload (CP)		Form of Teaching		Contact Hours per Week
(04-14-02	100-pr	Project in Mathematical Consulting			0		Projec	t	2
/ 	project. that ari The cor	o of matl The en se within sulting (ngineering stu n their projec group explor	cts as a mathem udents must be ct. es possible mat n with the engin	advis hema	ed in the trea	atment of	math	ematical	problems,
	Die Stuo Problen Sie kön	nen zu e nen sich	en haben gel erkennen und mit Studiere	ernt mathemat I vorab verschie enden anderer F ensweisen plau	dene [:] achri	n Lösungswe chtungen in d	ge zu erar	beite	า.	
9	solid kn	owledge		tion gebra, Calculus, ematics is desire		nerics, Stocha	tics, and A	ADM,	advanced	d
_			kamination:	on (Study Exami	natio	n, Special For	m, Passe	d / No	t Passed)
	-		on the Awar dienleistung	d of Credit Poin	ts					
	Grading Final M •	odule Ex		on (Study Exami	natio	n, Special For	m, Weigh	t: 100	%, Passe	d / Not
		•	e Module dium genera	le						
9	Literatı	ire								

	Anal	ysis I (N	laster o	f Education)	_				-	
04-	dule no. 30-)1/de	Credit I	Points 9 CP	Workload 270 h		f-study Duratio 165 h 1 Semes				-
Lan	guage of man	Instruct	tion	<u> </u>		on responsib Dr. rer. nat.				
1	Course	s of the	Module							
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0	003-tt	Analysis	I		0		Conve	ntion	1
	04-00-0	003-vu	Analysis	1		0		Lecture Exercis		6
2	Topolog Elemen Integra	und kom gie der r tare Fur Irechnur	eellen Za nktionen, ng, Haup	hlen, Vollständigkei hlen, Kompaktheit, Differenzierbare Fu tsatz der Differentia	Funktio	tionsbegriff, onen, Mittelw	Stetige F vertsatz,	unktior	nen,	r,
2	Reelle u Topolog Elemen Integra	und kom gie der r tare Fur	eellen Za nktionen, ng, Haup	hlen, Kompaktheit, Differenzierbare Fi	Funktio	tionsbegriff, onen, Mittelw	Stetige F vertsatz,	unktior	nen,	r,
	Reelle u Topolog Elemen Integra Integra Nach do - Funkti Stetigko - mathe - ihre Lo	und kom gie der r tare Fur lrechnur tionstec g Outco em Besu ionen ein eit, Diffe ematisch ernergeb	eellen Za hktionen, ng, Haup hniken mes ich des M ner reelle renzierb ie Schlus	hlen, Kompaktheit, Differenzierbare Fu tsatz der Differentia Ioduls können die S en Variablen mit gru arkeit, Vollständigk sfolgerungen mit ve Hinblick auf den M	Funktio unktio al- unc itudier undleg eit usv erschie	tionsbegriff, onen, Mittelw d Integralreck renden genden Konze w.) analysiere edenen Bewe	Stetige F vertsatz, nnung, epten (Gi en eismetho	unktior Satz vo renzwe den he	n Taylo rt, rleiten	r,
3	Reelle u Topolog Elemen Integra Integra Nach de - Funkti Stetigke - mathe - ihre Le Gymna	und kom gie der r tare Fur Irechnur tionstec g Outco em Besu ionen ein eit, Diffe ematisch ernergek sium ref	eellen Za hktionen, ng, Haup hniken mes ich des M ner reelle renzierb ne Schlus onisse im	hlen, Kompaktheit, Differenzierbare Fu tsatz der Differentia Noduls können die S en Variablen mit gru arkeit, Vollständigko sfolgerungen mit ve Hinblick auf den M	Funktio unktio al- unc itudier undleg eit usv erschie	tionsbegriff, onen, Mittelw d Integralreck renden genden Konze w.) analysiere edenen Bewe	Stetige F vertsatz, nnung, epten (Gi en eismetho	unktior Satz vo renzwe den he	n Taylo rt, rleiten	r,
3	Reelle u Topolog Elemen Integra Integra Nach de - Funkti Stetigke - ihre Le Gymna Require keine	und kom gie der r tare Fur Irechnur tionstec g Outco em Besu ionen ein eit, Diffe ematisch ernergek sium ref	eellen Za oktionen, og, Haup hniken o mes och des M ner reelle renzierb ie Schlus onisse im lektieren for Partic	hlen, Kompaktheit, Differenzierbare Fu tsatz der Differentia Noduls können die S en Variablen mit gru arkeit, Vollständigko sfolgerungen mit ve Hinblick auf den M	Funktio unktio al- unc itudier undleg eit usv erschie	tionsbegriff, onen, Mittelw d Integralreck renden genden Konze w.) analysiere edenen Bewe	Stetige F vertsatz, nnung, epten (Gi en eismetho	unktior Satz vo renzwe den he	n Taylo rt, rleiten	r,
2 3 4 5	Reelle u Topolog Elemen Integra Integra Integra Nach de - Funkti Stetigke - ihre Le Gymna Require keine	und kom gie der r tare Fur Irechnur tionstec g Outco em Besu ionen ein eit, Diffe ematisch ernergek sium ref ements f	eellen Za oktionen, og, Haup hniken o mes och des M ner reelle renzierb ie Schlus onisse im lektieren for Partic	hlen, Kompaktheit, Differenzierbare Fu tsatz der Differentia Moduls können die S en Variablen mit gru arkeit, Vollständigk sfolgerungen mit ve Hinblick auf den M h.	Funktio al- unc itudier undleg eit usv erschie	tionsbegriff, onen, Mittelw d Integralreck renden genden Konze w.) analysiere edenen Bewe	Stetige F vertsatz, nnung, epten (Gi en eismetho	unktior Satz vo renzwe den he	n Taylo rt, rleiten	r,

	Module Examination (Study Examination, Special Form, Passed / Not Passed)
6	Requirements on the Award of Credit Points
	Bestehen der Fachprüfung
,	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
	M. Ed. Mathematik
9	Literature
	H. Amman, J. Escher: Analysis II, Birkhäuser
	O. Forster: Analysis I, II. Vieweg
	M. Hieber: Analysis I, Springer
	K. Königsberger: Analysis 1, 2, Springer
	Charles R. MacCluer, Honors Calculus, Princeton Univ. Press
	W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment

Mo	dule nan	ne									
	Anal	ysis II (I	Master o	of Educatio	n)						
04-3	dule no. 30- 2/de	Credit	Points 9 CP	Workload	270 h		study 165 h	Duration		Freque Every 2	ncy . semester
	guage of man					Person responsible for the Module Prof. Dr. rer. nat. Matthias Hieber					
I		Courses of the Module Course no. Course name					Workload ((CP)	Form Teach		Contact Hours per Week
	04-00-0	002-tt	Analysis	II		0			Convent		1
	04-00-0	04-00-0002-vu Analysis II					0		Lecture Exercis		6

2	Study Content
	Konvergenz von Funktionenfolgen, Potenzreihen, Topologie metrischer Räume,
	Normen, Differentialrechnung mehrerer Variablen, partielle Ableitungen,
	Ableitungsregeln, Gradient,
	Höhere Ableitungen und Satz von Taylor in mehreren Variablen Lokale Extrema
	Lokale Umkehrbarkeit und implizite Funktionen
	Kurven, Wege und Vektorfelder
	Konvergenz von Fourrierreihen
	Parsevalsche Gleichung
3	Learning Outcomes
	Nach dem Besuch des Moduls können die Studierenden
	- Funktionen, die von mehreren Variablen abhängen, mit grundlegenden Konzepten
	(Stetigkeit, totale und partielle Differenzierbarkeit, Integration) analysieren
	 geometrische Zusammenhänge in mehrdimensionalen Räumen mit topologischen Grundkonzepten untersuchen
	- ihre Lernergebnisse im Hinblick auf den Mathematikunterricht am beruflichen
	Gymnasium reflektieren.
4	Requirements for Participation
	empfohlen: Analysis 1
5	Form of Examination
	Final Module Examination:
	Madula Evention (Technical Evention tion, and Evention tion, Duration, 20 min
	 Module Examination (Technical Examination, oral Examination, Duration 30 min, Standard)
	Stanuaru)
	Module Examination (Study Examination, Special Form, Passed / Not Passed)
6	Requirements on the Award of Credit Points
0	Bestehen der Fachprüfung
7	Grading
	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Weight: 100%,
	Standard)
	,
	Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not
	Passed)
8	Usability of the Module
	M. Ed. Mathematik
0	Literatura
9	Literature
	H. Amman, J. Escher: Analysis II, Birkhäuser O. Forster: Analysis I und II. Vieweg
L	

	M. Hieber: Analysis II, Springer K. Königsberger: Analysis 1,2 , Springer W. Rudin: Principles of Mathematical Analysis, McGraw-Hill
10	Comment

	dule nam		_1							
Integration TheoryModule no.Credit PointsW04-30-9 CP9 CP0015/de9 CP9 CPLanguage of Instruction			Workload 270 h	kload Self-study Du 270 h 180 h 1 S Person responsible f			nester Every 2. semeste			
	rman				Prof.	Dr. rer. nat.	Moritz E	gert		
1 Course Course		s of the no.	Module Course	name		Workload ((CP)	Form Teacł	-	Contact Hours per Week
	04-10-0	015-vu	Integrat	ation Theory		0		Lecture and Exercise		6
	theorer Part II:	m in R^n Convolu	change tion inte	inctions, Lebesgue i of variables formula grals, Fouriertransfo em, Stokes' theorer	a. orm; S					
3	After p		ion in th	is module students	are ab	le to				
	it with - choos - extend	the class e and ap d notion	ical Rien ply suita	of measures, constru- nann integral, able theorems of con neasure and integra- ulus	nverge	eneralized n		-		·
4	it with t - choos - extend theorer	the class e and ap d notion ms of ve ements f	ical Rien oply suita s from m ctor calc for Partic	nann integral, Ible theorems of con Neasure and integra- Ulus	nverge tion th	eneralized n		-		·

Final Module Examination:

• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)

Fachprüfung (Technical Examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.

6	Requirements on the Award of Credit Points
	Passing the Fachprüfung (Technical Examination)
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
	B.Sc. Mathematik, LaG Mathematik
9	Literature
	J. Elstrodt: Mass-und Integrationstheorie, Springer
	O. Forster: Analysis 3, Vieweg
	S. Lang: Real Analysis, Addison-Wesley
	H.Amann, J.Escher: Analysis III, Birkhäuser
10	Comment
10	recommended: Mathematics: Bachelor year 2, Teaching Degrees

Мос	dule nan	ne								
	Algo	rithmic	Discrete	e Mathematic	S					
Module no. 04-30- 0020/enCredit PointsWorkloadSelf-studyDurationFrequency5 CP150 h105 h1 SemesterEvery 2. semester										•
Lang Engl		Instruct	ion			Person responsib Prof. Dr. Yann Dis		Modu	ule	
1	Course	s of the I	Module							
	Course no. Course name				Workload (CP)	Form Teach	•	Contact Hours	

					per Week
	04-00-0005-vu	Algorithmic Discrete Mathemati	ics 0	Lecture and Exercise	3
2	spanning trees, completeness, s	rowth of functions and asymp shortest paths, matchings in I searching and sorting. onal topics: coding/cryptograp	pipartite graphs	and flows in directed g	raphs, NP-
3	-	mes this course, students will know wpoint on the example of prob			
4	-	for Participation Analysis, Linear Algebra			
5	min, Sta Fachprüfung (te when there are taken in the for communicated		the exam is take tial participants. on about the form	en in form of a written In this case, the exam m of the exam is taken	test, except can be and
6	-	on the Award of Credit Points hprüfung (technical examinati			
7	Grading Final Module Ex Module Standar	e Examination (Technical Exan	nination, oral / w	vritten Examination, W	eight: 100%,
8	Usability of the B.Sc. Mathemat	e Module tik, LaG Mathematik			
9	Literature				

10	Comment
	recommended: Mathematics: Bachelor year 2, Teaching Degrees

	Algel	ora								
Module no.Credit PointsWorkload04-30-9 CP270				Workload 270 h		study 180 h	Duration 1 Semes		Freque Every 2	e ncy 2. semester
	guage of man	Instruct	ion			on responsib . Dr. rer. nat.				
1	Course	s of the l	Module							
	Course	no.	Course	name		Workload ((CP)	Form Teach	-	Contact Hours per Week
	04-00-0)80-vu	Algebra			0		Lectur Exercis		6
3	Student - under - develo	stand an op a basi	id are ab c level o	le to apply the notion f understanding of the treated concepts	Galois	theory			in the co	ourse
4	-		or Partic Introduc	cipation ction to Algebra						
5	Final M Fachpro when tl taken ir	Module min, Sta ifung (te nere are	aminatio e Examin andard) echnical e only a sr m of an o	on: ation (Technical Ex- examination): Usual mall number of pote oral exam. The deci ne first two weeks c	lly the ential sion a	e exam is take participants. bout the form	en in form In this ca m of the e	n of a v ase, the exam is	vritten t e exam o s taken	est, excep can be and

6	Requirements on the Award of Credit Points Passing the Fachprüfung (technical examination)
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik
9	Literature J.C. Jantzen, J. Schwermer: Algebra, Springer S. Bosch: Algebra, Springer S. Lang: Algebra, Springer T.W. Hungerford: Algebra, Springer
10	Comment recommended: Mathematics: Bachelor year 3 (alg), Teaching Degrees

Мос	dule nan	ne									
	Diffe	rential	Geomet	ry (5 CP)							
04-3	dule no. 30- 5/de		Workload 150	h Self-		-	Duration 1 Semes			-	
-	Language of Instruction German						o n responsib Dr. rer. nat.				ker
1	Course	s of the	Module								
	Course no. Course			name			Workload (CP)		Form Teacł	••	Contact Hours per Week
	04-00-0133-vu Differential Geometry					()		Lectur Exercis		3
2	Study (Content									
3	Learnir	ng Outco	omes								
		-		nis module the stu ey know how to d							

	they are able to discuss examples of curves and surfaces.
4	Requirements for Participation
	Recommended: Analysis, gew. Differentialgleichungen, Lineare Algebra
5	Form of Examination
	Final Module Examination:
	 Module Examination (Technical Examination, oral / written Examination, Duration 60 min, Standard)
	Fachprüfung (technical examination): Usually the exam is taken in form of a written test, except
	when there are only a small number of potential participants. In this case, the exam can be
	taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of
	students taking the exam.
6	Requirements on the Award of Credit Points
	Passing the Fachprüfung (technical examination)
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Weight: 100%,
	Standard)
8	Usability of the Module
	B.Sc.Math math. Wahlbereich; Master: Ergänzungsbereich
9	Literature
	Bär: Elementare Differentialgeometrie Montiel,
	Ros: Curves and surfaces Hoschek, Lasser: Grundlagen der Geometrischen Datenverarbeitung
10	Commont
10	Comment

Module nam	Module name													
Diffe	Differential Geometry (5 CP)													
Module no.	Credit Points	Workload		Self-study		Duration	Frequency							
04-30-	5 CP		150 h		105 h	1 Semester	Every 2. semester							

003	5/en							
Lan	guage of Instruct	tion		Pers	on responsib	le for the	e Module	
Eng	lish			Prof	. Dr. rer. nat.	Elena Má	ider-Baumdic	ker
1	Courses of the	Module					1	
	Course no.	Course	name		Workload ((CP)	Form of Teaching	Contact Hours per Week
	04-00-0227-vu	Differen	tial Geometry		0		Lecture and Exercise	3
2	mean curvature	undamer e, surface	urvature; htal form, Gauß n es of revolution; lynomials, Bézie	perhaps	intrinsic geor	metry;		
3	curves and surf	ended t aces. The	his module the s ey know how to examples of cur	describe	surfaces in te			
4 5	Requirements for recommended:	Analysis	c ipation 5, gew. Differenti	ialgleichu	ıngen, Linear	e Algebra	1	
	min, Sta Fachprüfung (te when there are taken in the for	e Examir andard) echnical only a s m of an during t	nation (Technical examination): Us mall number of p oral exam. The c he first two wee	sually the potential decision a	e exam is take participants. about the form	en in forn In this ca m of the o	n of a written ase, the exam exam is taken	test, except can be and
6 7	-		ward of Credit P g (technical exan					
	Final Module Ex Module Standar	e Examir	on: nation (Technical	l Examina	ation, oral / w	vritten Ex	amination, W	eight: 100%

8	Usability of the Module B.Sc.Math math. Wahlbereich; Master: Ergänzungsbereich
9	Literature Bär: Elementare Differentialgeometrie Montiel, Ros: Curves and surfaces Hoschek, Lasser: Grundlagen der Geometrischen Datenverarbeitung
10	Comment

Мо	dule nan	ne									
	Func	tional A	nalysis								
Module no.Credit PointsWorkload04-30-9 CP270				270 h					Freque Every 2	Juency ry 2. semester	
	guage of man	Instruct	ion				on responsib Dr. rer. nat.				
1	Course	s of the I	Module			•					
	Course no. Course		Course	name	ime		Workload (CP)		Form Teach	-	Contact Hours per Week
	04-00-0	069-vu	Functior	al Analysis			0		Lectur Exercis		6
2	Norme Open N conver	lapping gence; So	Theorem bolev s	completion; Tl n, Closed Grap paces, weak so ct operators c	h The olutio	orem n of tl	; Hilbert spac ne Dirichlet p	ces; reflex roblem; s	cive spa spectra	aces, we al proper	ak rties of
3	Learning Outcomes Students learn to - combine ideas from linear algebra, analysis and topology - understand and explain basic principles of functional analysis - explain methods from functional analysis in the context of partial differential equations										
4	Requirements for Participation recommended: Analysis, Integration Theory, Complex Analysis, Linear Algebra or comparable prerequisites acquired in mathematics courses in engineering programmes										

5	Form of Examination
	Final Module Examination:
	• Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung: Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung (technical examination)
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics
9	Literature Alt: Lineare Funktionalanalysis; Conway: A Course in Functional Analysis; Reed, Simon: Functional Analysis: Methods of Modern Mathematical Physics I; Rudin: Functional Analysis; Werner: Funktionalanalysis; Ciarlet: Functional Analysis;
10	Comment recommended: Mathematics: Bachelor year 3 (ana)

Module name												
Num	Numerical Methods for ordinary differential equations (5 CP)											
Module no. 04-30- 0042/de	Credit Points 5 CP	Workload	150 h	Self-study 105 h	Duration 1 Semester	Frequency Every 2. semester						
Language of German	Instruction			Person responsible for the Module Prof. Dr. rer. nat. Jan Giesselmann, Prof. Dr. rer. nat.								

		Jei	ns Lang								
1	Courses of the Module										
	Course no.	Course name	Workload (CP)	Form of Teaching	Contact Hours per Week						
	04-10-0134-vu	Numerics of ordinary differential equations - Initial value problems	0	Lecture and Exercise	3						
2	Study Content initial value problems: one-step methods, multi-step methods; convergence analysis, notions of stability; boundary-value problems: Shooting methods, finite difference methods, stability and convergence;										
3		mes the basic numerical solution co analyze, compare, and apply t		ifferential equat	ions and						
4	Requirements for Participation recommended: Analysis, Linear Algebra, Ordinary Differential Equations, Introduction to Numerical Analysis or similar knowledge as taught in an engineering programme.										
5	min, Sta Fachprüfung (te when there are taken in the for communicated	kamination: e Examination (Technical Exami	he exam is taken in fo al participants. In this about the form of th	orm of a written s case, the exam ne exam is taken	test, except can be and						
6	-	on the Award of Credit Points hprüfung (technical examinatio	n)								
7	Grading Final Module Ex Module Standar	e Examination (Technical Exami	nation, oral / written	Examination, W	eight: 100%						
8	Usability of the B.Sc. Mathemat	e Module tik, M.Sc Mathematik, M.Sc. Ma	thematics								

	M.Sc. ETIT
9	Literature Deuflhard, Bornemann: Numerische Mathematik 2 Stoer, Bulirsch: Numerische Mathematik 2
10	Comment recommended: Mathematics: Bachelor year 3 (num) The course is read in blocks of 4+2 hours during the first eight weeks of the semester.

Mo	dule nan	ne								
Mo	Prob dule no.	ability 1 Credit F		Workload	Solf	-study	Duratio	n	Freque	
04-3 004	30- 5/de	Cleantr	9 CP	270		•	Duration 1 Semester		Frequency Every 2. semester	
	guage of man	Instruct	ion			on responsit				
1	Course	s of the l	Module			1				
Course		ourse no. Course		e name		Workload ((CP)	Form of Teaching		Contact Hours per Week
	04-00-0	141-vu	Probabil	ity Theory		0		Lecture and Exercise		6
	conver	gence, cl ations, m	naracteri	ndations, theory of stic functions, stor es in discrete time	chastic	independen	ce, 0-1-la	ws, co	nditiona	I
3	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of probability theory - are able to recognise the treated concepts in various fields of mathematics.									
4	-	ements f nended:		ipation , Integration Theo	ry, Intr	roduction to S	Stochasti	cs		
5		f Examir odule Ex		on:						

	Module Examination (Technical Examination, oral / written Examination, Duration 90								
	min, Standard)								
	Fachprüfung (technical examination): Usually the exam is taken in form of a written test, except								
	when there are only a small number of potential participants. In this case, the exam can be								
	taken in the form of an oral exam. The decision about the form of the exam is taken and								
	communicated								
1	during the first two weeks of the lecture, based on the prospective number of students taking								
	the exam.								
6	Requirements on the Award of Credit Points								
	Passing the Fachprüfung (technical examination)								
7	Grading								
	Final Module Examination:								
	Module Examination (Technical Examination, oral / written Examination, Weight: 100%,								
	Standard)								
8	Usability of the Module								
	B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics, LaG Mathematik								
9	Literature								
	Bauer: Probability Theory								
	Billingsley: Probability and Measure								
	Elstrodt: Maß-und Integrationstheorie Gänssler, Stute: Wahrscheinlichkeitstheorie								
	Klenke: Wahrscheinlichkeitstheorie								
10	Comment								

Мос	dule nam	ne									
	Prob	ability 1	Theory								
Module no.		Workload	270 h	Self-	study 180 h		Duration 1 Semester		cy semester		
Language of Instruction English						Person responsible for the Module Prof. Dr. rer. nat. Volker Martin Betz					
1 Courses of the Module											
	Course no. Course name			Workload (CP)	Form	of	Contact			

	-			I					
				Teaching	Hours per Week				
	04-00-0071-vu	Probability Theory	0	Lecture and Exercise	6				
2	convergence, cl	etical foundations, theory of naracteristic functions, stoc nartingales in discrete time,	hastic independer	nce, 0-1-laws, conditiona	ıl				
3	Students - understand ar - develop a basi	Learning Outcomes Students - understand and are able to apply the notions, methods and results treated in the course - develop a basic level of understanding of probability theory - are able to recognise the treated concepts in various fields of mathematics.							
4	-	for Participation Analysis, Integration Theor	y, Introduction to	Stochastics					
5	min, Sta Fachprüfung (te when there are taken in the for communicated	camination: e Examination (Technical Ex andard) echnical examination): Usua only a small number of pot m of an oral exam. The deci	lly the exam is tak ential participants sion about the for	ten in form of a written t s. In this case, the exam rm of the exam is taken	test, except can be and				
6	Requirements on the Award of Credit Points Passing the Fachprüfung (technical examination)								
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard) 								
8	Usability of the B.Sc. Mathemat	Module tik, M.Sc Mathematik, M.Sc.	. Mathematics, La	G Mathematik					
9	Literature Bauer: Probabil	ity Theory							

	Billingsley: Probability and Measure Elstrodt: Maß-und Integrationstheorie Gänssler, Stute: Wahrscheinlichkeitstheorie Klenke: Wahrscheinlichkeitstheorie
10	Comment recommended: Mathematics: Bachelor year 3 (sto), Teaching Degrees

Мо	dule nan	ne							
	Non-	Acaden	nic Inter	nship (PO 2024)					
Мо	dule no.	Credit P	oints	Workload	Self-study	Duration)	Frequer	ncy
04-	30-0051		3 CP	90 h	90 h	1 Semest	ter	Every 2.	semester
	guage of man and		ion		Person responsit	le for the	Modul	le	
1	Course	s of the I	Module						
	Course no.		Course	name	Workload (CP)		Form of Teaching		Contact Hours per Week
2		ering or		ip in a company or k environment of a			n in a lo	cation r	eflecting
3	The stu		perience	e a realistic working how mathematicia				They ca	n work in
4	Requirements for Participation Students need to find and organize their internship on their own.Internships need to be suitable for mathematicians. If this is the case only for parts of the internship, ist duration needs to be proportionally greater. Suitability for mathematicians is determined by a lecturer of the department of mathematics.								
5	Final M		aminatio e Examir	on: hation (Study Examin h and oral presentat		-	-		
6	Requirements on the Award of Credit Points								

	Passing the Studienleistung (study examination)
7	Grading
	Final Module Examination:
	 Module Examination (Study Examination, Special Form, Weight: 100%, Passed / Not Passed)
8	Usability of the Module
	Master of Science PO 2024
9	Literature
10	Comment
	3 weeks / 90 hours
	Recommended for Master PO 2024

ivic	dule nan Foun		s of Tead	hing and Learnir	ig of I	Vathematic	s			
Мо	dule no.			Workload	Ť	study	Duratio	n	Freque	ency
04-3	30-0087		8 CP	240 ł	ı	180 h	1 Semes	ter	Every	2. semester
Language of Instruction German						on responsib . Dr. phil. nat			ule	
1	Course	s of the	Module							
	Course no.		Course name			Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-0107-ps		Specialized didactics for undergraduates			0		Proseminar		0
	04-00-0	179-vu	Teaching Mathem	g and Learning of atics		0		Lectur Exercis		4
2	Study Content Modelle zur Behandlung typischer Unterrichtssituationen, Umgang mit Heterogenität, Aufgabentheorie, Ziele und Inhalte des Mathematikunterrichts mit Begründungen, Wege zum langfristigen Kompetenzaufbau									
3	Die Stu typisch	e mathe	en könne matische	n unterschiedliche Lehr- und Lernsiti n auswählen und g	uation	en in heterog	genen Ler	ngrupp	oen bes	chreiben

	sie können die Ziele und Inhalte mathematischer Lernumgebungen begründen
4	Requirements for Participation Mathematik als gemeinsame Sprache der Naturwissenschaften und Analysis und Lineare Algebra oder vergleichbare Vorkenntnisse (Teilnahme ohne Nachweis möglich)
5	Form of Examination Final Module Examination: • Module Examination (Technical Examination, Special Form, Standard) • Module Examination (Study Examination, Special Form, Standard) • Fachprüfung: Sonderform (Mündliche Prüfung mit Portfolioanteilen) Studienleistungen: In der Vorlesung: Sonderform (In der Regel erfolgreiche Bearbeitung eines Teils der Hausübungen zur Vorlesung und aktive Mitarbeit in den Übungen. Die Anzahl sowie das Bewertungsschema als Studienleistung wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben. Im Proseminar aktive Mitarbeit in den Seminarsitzungen, Führen eines E-Portfolios, ein Kurzvortrag und eine darauf bezogene schriftliche Ausarbeitung).
6	Requirements on the Award of Credit PointsBestehen der Fachprüfung; Bestehen der Studienleistungen als Zulassungsvoraussetzung zur FachprüfungErfolgreiche Teilnahme zu 75%* an den Lehrveranstaltungen [04-00-0107-ps / Fachdidaktisches Proseminar; 04-00-0179-vu / Übung zu Lehren und Lernen von Mathematik].Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z.B. von Erfahrungen mit Unterrichtsmethoden und -materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.
7	Grading Final Module Examination: • Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) • Module Examination (Study Examination, Special Form, Weight: 0%, Standard) • Module Examination (Study Examination, Special Form, Weight: 0%, Standard) • Module Examination (Study Examination, Special Form, Weight: 0%, Standard) • Module Examination (Study Examination, Special Form, Weight: 0%, Standard) • Module Examination (Study Examination, Special Form, Weight: 0%, Standard)
9	Literature Bruder, R., Hefendehl-Hebeker, L., Schmidt-Thieme, B. Weigand, HG. (Hrsg.) (2015). Handbuch der Mathematikdidaktik. Springer Berlin Heidelberg.

	Bruder, R., Büchter, A. Leuders, T. (2008). Mathematikunterricht entwickeln. Bausteine für kompetenzorientiertes Unterrichten. Cornelsen Scriptor.
10	Comment

Мо	dule nan	ne											
	Linea	r Algek	ora (Bac	helor of Educ	atior)				1			
04-	dule no. 30- 24/de	Credit	Points 9 CP	Workload 2	270 h	Self	- study 180 h	Duratio 2 Semes		Freque Every 2	e ncy 2. semester		
Lan	guage of	Instruc	tion			Person responsible for the Module							
							Prof. Dr. rer. nat. Jan Hendrik Bruinier						
1	Course		Course	name			Workload ((CP)	Form Teacl		Contact Hours per Week		
	04-00-0	067-vu		lgebra II (for Phy g Degrees (Math	-		0	Lectur Exercis		3			
	04-00-0	117-vu		lgebra I (for Physics and g Degrees (Mathematics))			0		Lecture and Exercise		3		
	Gleichu Transfo	ngssyste rmatior	eme, Det 1en, symr	e Abbildungen erminanten, E netrische, hen ng und Normal	igenv mites	verte che ι	, orthogonale	und unit	täre				
3	Die Stu insbesc Eigenw im Hink mather reflekti	ondere a erte und olick auf natische eren ihr	en kenne nalytisch d Orthoge die gena e Beweise	en Konzepte, B le Geometrie, ' onalisierung. S nnten Themer e nachzuvollzie gebnisse im Hin	Vekto ie sin nfelde ehen u	orräui d bef er mit und ii	me und linear ähigt, mather den erlernte n einfachen Fa	e Abbild matische n Metho ällen zu f	ungen, Lösun den an ühren.	Matrize gsstrate zuwend Sie	gien		
4	Require keine	ements	for Partio	cipation									
5	Form o	f Examiı	nation										

	Final Module Examination:
	 Module Examination (Technical Examination, oral Examination, Duration 30 min, Standard)
	Studienleistung: In der Regel erfolgreiche Bearbeitung eines Teils der Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung wird
	während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.
6	Requirements on the Award of Credit Points Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral Examination, Weight: 100%, Standard)
8	Usability of the Module Mathematik: Lehramt an beruflichen Schulen
9	Literature K. Jänich: Lineare Algebra G. Fischer: Lineare Algebra G. Fischer: Lernbuch Lineare Algebra und Analytische Geometrie, Springer Vieweg, 2012 P. Halmos: Finite-dimensional vector spaces
10	Comment

Mo	dule nan	ne									
	Semi	nar in N	/lathem	atics (alg),	Maste	r, FB In	formatik				
04-3	dule no. 30- 9/de	Credit F	Points 6 CP	Workload	180 h	Self-st	•	Duratior 1 Semes	-	Frequen Every 2.	cy semester
	guage of man	Instruct	ion			Persor	n responsik	le for the	Modu	ule	
1	Course	s of the l	Module								
	Course	no.	Course	name		v	Vorkload (CP)	Form Teacl	-	Contact Hours

					per Week
	04-00-0203-se	Seminar in Mathematics (alg), Master	0	Seminar	2
2	Study Content special topics o	f Algebra, Geometry, Function	al Analysis		
3	Sachverhalte ar und präsentiere	omes en können sich eigenständig ar neignen und in einem ansprech en, sowie gegebenfalls schriftli e faire Diskussion über Inhalte	nenden Fachvortra ch dokumentierei	ag erläutern 1.	
4	-	for Participation dule nach Angabe			
5	Form of Examin Course Examina • [04-00		oral / written Exa	mination, Standard)
6	Requirements	on the Award of Credit Points			
7	Grading Course Examina • [04-00 Standa	-0203-se] (Study Examination,	oral / written Exa	mination, Weight: 1	00%,
8	Usability of the Vertiefungsber	e Module eich (Studienleistung)			
9	Literature depending on t	opic			
10	Comment Verantwortlich	: Studiendekan			

Module name

Seminar in Mathematics (geo), Master, FB Informatik

	lule no.	Credit F	Points	Workload		Self-	study		Duratior	1	Freque	ency
04-3 0141			6 CP		180 h		-	L50 h	1 Semes	ter	-	2. semester
Lang Gerr	-	Instruct	ion			Pers	on resp	onsib	le for the	Modu	ıle	
1		s of the l	Module									
-	Course		Course	name			Workl	oad ((CP)	-	orm of Conta eaching Hour per Weel	
	04-00-02	205-se	Seminar Master	in Mathemat	tics (geo),	0			Semina	ar	2
2	Study C special		f geomet	ry and appr	oximati	on						
3	Learning Outcomes Die Studierenden können sich eigenständig anspruchsvolle mathematische Sachverhalte aneignen und in einem ansprechenden Fachvortrag erläutern und präsentieren, sowie gegebenfalls schriftlich dokumentieren. Sie können eine faire Diskussion über Inhalte und Darstellung des Vortrages, führen.											
4	-		or Partic dule nach	ipation Angabe								
5		f Examin Examina [04-00-	ation:] (Study Exa	minatio	n, ora	l / writ	ten Ex	aminatio	n, Stai	ndard)	
6	Require	ements o	on the Av	ward of Cre	dit Poin	ts						
7	Grading Course	Examina	-0205-se] (Study Exa	minatio	n, ora	l / writi	ten Ex	aminatio	n, Wei	ght: 100	0%,
8		•	Module eich (Stu	dienleistung	;)							
9	Literatı depend	ire ling on to	opic									
10	Comme Verantv		Studien	dekan								

	Semi	nar in N	/lathem	atics (log), Maste	r, FB Informatik						
04-	dule no. 30- 12/de	Credit F	Points 6 CP	Workload 180 h	Self-study 150 h	Duration 1 Semester	-	uency y 2. semester			
	guage of man	Instruct	ion		Person responsib	le for the N	/lodule				
1	Course	s of the	Module								
	Course no. Cou			name	Workload ((-	orm of eaching	Contact Hours per Week			
	04-00-0206-se Seminar Master			in Mathematics (log)	, 0	Se	eminar	2			
2	Study Content special topics of logic										
	Die Studierenden können sich eigenständig anspruchsvolle mathematische Sachverhalte aneignen und in einem ansprechenden Fachvortrag erläutern und präsentieren, sowie gegebenfalls schriftlich dokumentieren. Sie können eine faire Diskussion über Inhalte und Darstellung des Vortrages, führen.										
	fuhren. Requirements for Participation Vertiefungsmodule nach Angabe										
4	Require	ements f		-							
4	Require Vertief	ements f ungsmoo f Examin Examina	dule nach nation ation:	-	n, oral / written Ex	amination,	Standard)			
	Require Vertieft Form o Course	ements f ungsmoo f Examir Examina [04-00-	dule nach nation ation: -0206-se	n Angabe		amination,	Standard)			

8	Usability of the Module Vertiefungsbereich (Studienleistung)
9	Literature depending on topic
10	Comment Verantwortlich: Studiendekan

Мо	dule nan	ne								
	Num	erical N	/lethods	for ordinary diffe	erent	ial equation	S			
04-3	dule no. 30- 3/de	Credit I	Points 9 CP	Workload 270 h		Self-study Duratio 180 h 1 Semes				
	guage of man	Instruct	ion		Prof	on responsib . Dr. rer. nat. Lang				Dr. rer. nat.
1	Course	s of the	Module							
	Course	no.	Course	name	Workload (CP)		Form Teacł	-	Contact Hours per Week	
	04-00-0138-vu Numerics of Ordinary Diffe Equations					0		Lecture Exercis		6
2	stability bounda conver	alue pro /; ary-value gence;	e problen	ne-step methods, n ns: Shooting metho tions: Finite differer	ds, fir	nite difference	e methoc	ls, stab	oility and	notions of
3	Studen		some ba	sic numerical soluti ential equations. The		•	-		•	
4	recomr	nended:	•	c ipation , Linear Algebra, Or milar knowledge as		•	•	•		to
5		f Examir odule E>	nation kaminatio	on:						

	 Module Examination (Technical Examination, oral / written Examination, Duration 90 min, Standard)
	Fachprüfung (technical examination): Usually the exam is taken in form of a written test, except when there are only a small number of potential participants. In this case, the exam can be taken in the form of an oral exam. The decision about the form of the exam is taken and communicated during the first two weeks of the lecture, based on the prospective number of students taking the exam.
6	Requirements on the Award of Credit Points Passing the Fachprüfung (technical examination)
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module B.Sc. Mathematik, M.Sc Mathematik, M.Sc. Mathematics (nicht zusammen mit 04-30-0042/de, 04-10-0042/de oder 04-10-0393/de belegbar)
9	Literature Deuflhard, Bornemann: Numerische Mathematik 2 Stoer, Bulirsch: Numerische Mathematik 2
10	Comment recommended: Mathematics: Bachelor year 3 (num)

Mo	dule nan	ne									
	Diffe	rential	Geomet	ry							
04-3	dule no. 30- 7/de	Credit F	Points 9 CP	Workload	270 h	Self-s	•	Duratior 1 Semes	-	Freque Every 2	ncy semester
	guage of man	Instruct	ion				on responsib Dr. rer. nat.				er
1	Course	s of the	Module								
	Course	no.	Course	name			Workload ((CP)	Form Teacl	•••	Contact Hours per Week

	04-10-0507-vu	Differential Geometry	0	Lecture and Exercise	6
2	operator; princ	curvature; selected global theor ipal curvatures, Gaussian and m llel transport, Gauss-Bonnet Th	nean curvature. Compa	tibility equation	• •
3	curves and surf	mes ended this module the student aces. They know how to descril d the difference between intrin	be surfaces in terms of	differential geo	metry and
4	-	for Participation Analysis, Ordinary Differential	Equations, Linear Algeb	ora	
5	min, Sta				
	when there are taken in the for communicated	only a small number of potent m of an oral exam. The decision two weeks of the lecture, base	ial participants. In this on about the form of the	case, the exam exam is taken	can be and
6	Requirements	on the Award of Credit Points			
7	Grading Final Module Ex Modul Standa	e Examination (Technical Exam	ination, oral / written E	xamination, W	eight: 100%,
8	Usability of the B.Sc. Mathema	tik, M.Sc Mathematik, M.Sc. Ma	athematics, LaG Mathe	matik	
9	Montiel, Ros: C	e Differentialgeometrie urves and surfaces r: Grundlagen der Geometrisch	en Datenverarbeitung		
10	Comment				

Мо	dule nan	ne								
	dule no.	rential Credit F	Geomet Points	ry Workload	Self-st	udy	Duratio	n	Freque	ncy
04-3 050	30- 17/en		9 CP	270 h		180 h	1 Semes	ter	Every 2	. semester
	guage of lish	Instruct	ion			n responsib Dr. rer. nat.				er
1	Course	s of the	Module							
	Course	no.	Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-10-0	507-vu	Differen	tial Geometry	0			Lectur Exercis		6
3	shape operator; principal curvatures, Ga geodesics, parallel transport, Gauss-Bon Learning Outcomes After having attended this module the s curves and surfaces. They know how to				lents ha	ive develop urfaces in te	ed an int erms of d	uition	for curva tial geor	
4	Require	ements f	or Partic	ference between in cipation , Ordinary Differetia			-		antities.	
5			kaminatio e Examin	on: hation (Technical Ex	aminati	ion, oral / w	vritten Ex	aminat	tion, Dur	ation 90
	when the taken in commu	ufung (te here are h the for inicated the first	echnical e only a sr m of an e	eamination): Usuall mall number of pote oral exam. The deci ks of the lecture, ba	ential p sion ab	articipants. out the forr	In this ca n of the e	ase, the exam is	e exam c s taken a	an be Ind

6	Requirements on the Award of Credit Points
	Passing the Fachprüfung (technical examination)
7	 Grading Final Module Examination: Module Examination (Technical Examination, oral / written Examination, Weight: 100%, Standard)
8	Usability of the Module
9	Literature Bär: Elementare Differentialgeometrie Montiel, Ros: Curves and surfaces Hoschek, Lasser: Grundlagen der Geometrischen Datenverarbeitung
10	Comment recommended: Mathematics: Bachelor year 3 (geo), Teaching Degrees

		uuctioi		ebra and Didactics							
Module no. 04-30- 0520/de		Credit I	Points 8 CP	Workload 240 h	Self-study 135 h	Duration 1 Semester	•	Frequency Every 2. semester			
Lan	guage of	Instruc	tion		Person responsit	le for the Mo	dule				
Ger	man				Prof. Dr. phil. nat	. Katja Krüger					
1	Courses of the Module										
	Course no. Cour			name	Workload (-	n of ching	Contact Hours per Week			
	04-00-0006-vu		Introduction to Algebra		0	Lectu Exerc	ire and cise	3			
				for subject-specific s: Algebra in schools	0	Proje	ect	4			
2	Study C	Study Content									
	Elementare Gruppentheorie, Gruppenwirkungen, Ringe, Teilbarkeit, Polynomringe, Moduln. Zahlbereichserweiterungen und Behandlung von Gleichungen und Termen in den beiden Sekundarstufen, Rechnen können, Technologieeinsatz, Teilbarkeitsuntersuchungen; typische Schülerfehler, Aufbau von Grundvorstellungen, Möglichkeiten der Nutzung von Strategien, Prinzipien und Modellen für die Entwicklung eines Spiralcurriculums bis zur Sekundarstufe II.										

3	Learning Outcomes Die Studierenden verstehen die grundlegenden Begriffe und Methoden der Theorie der Gruppen, Ringe und Moduln. Sie können diese auf typische Fragestellungen anwenden. Die Studierenden erlangen fachliche Sicherheit in schulrelevanten Aspekten der Algebra und Zahlentheorie. beherrschen Darstellungen und Konzepte, um Themengebiete der Algebra in der Schule zu veranschaulichen, sprachsensibel und binnendifferenzierend zu gestalten. praktizieren in den Übungen zahlreiche Beispiele für intelligentes Üben und Begabtenförderung und entwickeln ihre diagnostische Kompetenz								
4	Requirements for Participation Analysis, Lineare Algebra, Grundlagen des Lehrens und Lernens von Mathematik (Teilnahme ohne Nachweis möglich)								
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Homework, Worksheets, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Duration 45 min, Standard) Fachprüfung: Sonderform (Mündliche Prüfung mit Portfolioanteilen) Studienleistung: Sonderform (In der Vorlesung in der Regel eine erfolgreiche Bearbeitung eines Teils der Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben. Im Seminar in der Regel aktive Mitarbeit in den Seminarsitzungen und erfolgreiche Bearbeitung von Lernaufträgen wie z.B. Hausübungen oder ein Semesterprodukt. Die Kriterien diesbezüglich werden während des ersten Veranstaltungstermins durch die Prüfer bekannt gegeben.) 								
6	Requirements on the Award of Credit Points Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung. Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung [/04-00-0039-se Fachdidaktisches Seminar: Algebra in der Schule]. Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z.B. von Erfahrungen mit Unterrichtsmethoden und -materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.								
7	Grading Final Module Examination:								

	 Module Examination (Study Examination, Homework, Worksheets, Weight: 0%, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
8	Usability of the Module Mathematik: Lehramt
9	Literature S. Lang: Algebra, Addison-Wesley; N. Jacobson: Basic Algebra 1, Freeman S. Bosch: Algebra, Springer Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Malle, G. (1993). Didaktische Probleme der elementaren Algebra. Vieweg, Braunschweig/Wiesbaden. Gängige Schulbücher
10	Comment

	Com	plex An	alysis a	nd Didactics of A	Analysi	S					
Module no. 04-30- 0521/de		Credit Points 8 CP		Workload 240		-study 165 h	Duration 1 Semester		Frequency Every 2. semest		
Language of Instruction German and English						on responsib			9		
1	Courses of the Module										
	Course no.		Course name			Workload (CP)		Form of Teaching		Contact Hours per Week	
	04-00-0159-se		Seminar for subject-specific didactics: Analysis in schools			0	5	Seminar		2	
	04-00-0225-vu Cor		Complex Analysis			0			and	3	
2	Study C	Content					·				
	Cauchy Umlauf Funktio Rieman	Cauchy-Riemann Differentialgleichungen, Kurvenintegrale, Cauchy'scher Integralsatz, Cauchy'sche Integralformel, Potenzreihen, Satz von Liouville und Hauptsatz der Algebra, Umlaufzahl Laurentreihen und isolierte Singularitäten, Residuensatz Funktionspropädeutik, Funktionsuntersuchungen, Lokale Änderungsrate und Grenzwertbegriff Riemannscher Integralbegriff, Anwendungen der Infinitisemalrechnung in der Schule, Fehlvorstellungen von Schülern; Oberstufencurriculum,									

	Unterrichtsgestaltung, Technologieeinsatz
3	Learning Outcomes
	Nach dem Besuch des Moduls
	- sind sie mit den Cauchy-Riemannschen DGL vertraut
	- können sie Kurvenintegrale analysieren und berechnen
	- sind sie mit dem Cauchyschen Integralsatz und der Cauchyschen Integralformel vertraut und
	können deren Implikationen aufzeigen
	- sind sie mit der Bedeutung der Potenzreihen in der Funktionen-theorie vertraut
	- können sie den Satz von Liouville und den Hauptsatz der Algebra erklären
	- können sie Laurentreihen analysieren
	- können sie isolierte Singularitäten anhand konkreter Beispiele erklären
	-sind mit dem Residuensatz und dessen Implikationen vertraut
	Die Studierenden
	erlangen fachliche Sicherheit in besonders schulrelevanten Aspekten der Analysis und können
	verschiedene Zugänge und Schwerpunktsetzungen gegeneinander abwägen.
	beherrschen Darstellungen und Konzepte, um Themengebiete der Analysis in der Schule zu
	veranschaulichen - auch mit Technologieeinsatz.
	praktizieren in den Übungen zahlreiche Beispiele für intelligentes Üben, Diagnose und
	Förderung.
5	(Teilnahme ohne Nachweis möglich) Form of Examination Final Module Examination:
	• Module Examination (Technical Examination, Special Form, Duration 45 min, Standard)
	 Module Examination (Study Examination, Homework, Worksheets, Passed / Not Passed)
	Fachprüfung: Sonderform (Mündliche Prüfung mit Portfolioanteilen)
	Studienleistung: Sonderform (In der Vorlesung in der Regel eine erfolgreiche Bearbeitung eines Teils der Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben. Im Seminar in der Regel aktive Mitarbeit in den Seminarsitzungen und erfolgreiche Bearbeitung von Lernaufträgen wie z.B. Hausübungen oder ein Semesterprodukt. Die Kriterien diesbezüglich werden während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.)
6	Requirements on the Award of Credit Points
	Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung [/04-00-0159-se Fachdidaktisches Seminar: Analysis in der Schule].

	Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z.B. von Erfahrungen mit Unterrichtsmethoden und -materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.								
7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Homework, Worksheets, Weight: 0%, Passed / Not Passed) 								
8	Usability of the Module Mathematik: Lehramt								
9	Literature Freitag: Funktionentheorie I, Springer. Remmert: Funktionentheorie I Conway: Functions of one complex variable, Springer Tietze, UP., Klika,M., Wolpers, HH.: Mathematikunterricht in der SII, Bd. 1, Fachdidaktische Grundfragen, Didaktik der Analysis. Vieweg 2000, Büchter, A., Henn, HW.: Elementare Analysis: Von der Anschauung zur Theorie. Spektrum 2010. Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Kratz, Henrik (2011). Wege zu einem kompetenzorientierten Mathematikunterricht – Ein Studien- und Praxisbuch für die Sekundarstufe. Kallmeyer – Klett, Seelze Gängige Schulbücher								
10	Comment								

Module name											
Ordinary Differential Equations and Media-Based Teaching and Learning											
Module no. 04-30- 0522/deCredit Points 8 CPWorkload240 h							study 16	yDurationFrequency165 h1 SemesterEvery 2. sem			•
Language of Instruction German						Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger					
1 Courses of the Module											
Course no. Course name					Workloa	ad (C	CP)	Form Teach	-	Contact Hours	

					per Week
	04-00-0054-vu	Ordinary Differential Equations	0	Lecture and Exercise	3
	04-00-0249-se	Seminar for subject-specific didactics: Digital media in mathematical lessons	0	Seminar	2
2	lineare Systeme linearisierter St Technische Mö Tabellenkalkula	Yariablen, Sätze von Picard-Linde e erster und höherer Ordnung, V abilität, Lyapunov-Stabilität. glichkeiten, didaktische Konzep ationsprogrammen, dynamische grammierung und didaktischer H	/ariation-der-Kons te und Anwendun r Geometriesoftw	stanten-Formel, Prir gsbeispiele zu	nzip
3	Nach dem Besu - können sie die - sind sie mit de vertraut - können sie lin - können sie die - können sie der können. Die Studierende erlangen Gru mit Taschenrec	iele / Lernergebnisse ich des Moduls e Methode der Trennung der Va en Sätzen von Picard-Lindelöf ur er lokalen und globalen Existenz eare Systeme erster und höhere e Variation der konstanten Form s Prinzip linearisierter Stabilität n Begriff der Lyapunov Stabilität	nd Peano vertraut theorie gewöhnlic er Ordnung analys nel entwickeln formulieren und a erklären und auf Mathematikprogr Whiteboards und	ieren anwenden konkrete Beispiele a ramm-kategorien, ir I im Programmieren	anwenden n Umgang
4	Analysis und Lii Mediendidaktil	for Participation neare Algebra und Grundlagen o < (Vernetzungsbereich). ne Nachweis möglich)	les Lehrens und Le	ernens von Mathem	atik,
5		xamination: e Examination (Technical Exami e Examination (Study Examinati	-		
		onderform (Mündliche Prüfung g: Sonderform (In der Vorlesung		-	itung eines

6	Prüferin/den Prüfer bekannt gegeben.) Requirements on the Award of Credit Points Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung. Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung (04-00-0249-se / Fachdidaktisches Seminar: Medien in der Schule). Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z.B. von Erfahrungen mit Unterrichtsmethoden und -materialien
6	Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung. Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung (04-00-0249-se / Fachdidaktisches Seminar: Medien in der Schule). Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende
	Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung. Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung (04-00-0249-se / Fachdidaktisches Seminar: Medien in der Schule). Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende
	Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung (04-00-0249-se / Fachdidaktisches Seminar: Medien in der Schule). Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende
	Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende
	sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die
	Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene
	Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.
7	Grading
	Final Module Examination:
	• Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
	 Module Examination (Study Examination, Homework, Worksheets, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
	Mathematik: Lehramt
9	Literature
	H. Amann: Gewöhnliche Differentialgleichungen, de Gruyter W.Walther: gew. DGL, Springer
	Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer.
	Barzel, B., Hußmann, S., Leuders, T. (2005): Computer, Internet Co. im Mathematik-Unterricht.
	Cornelsen Verlag Scriptor. Artikel aus "mathematik lehren" und gängige Schulbücher
10	Comment

Module nam	ne				
Elem	entary Numbe	r Theory and Dida	ctics of Algebra		
Module no.	Credit Points	Workload	Self-study	Duration	Frequency

04-3	80-		8 CP	240 h		135 h	1 Semes	ter	Every 4	. semester
	3/de		0 01	21011		100 11	1 Series		LVCIY	. semester
Lang	guage of	Instruct	ion		Pers	on responsib	le for the	e Mod	ule	
Geri	man				Prof	. Dr. phil. nat	Katja Kr	üger		
1	Courses	s of the	Module							
	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week
	04-00-00	039-pj		for subject-specific : Algebra in schools		0		Projec	t	4
	04-10-03	389-vu	Elementa (Lehramt	ary Number Theory)		0		Lectur Exercis		3
2	Study C	ontent								
	Problen Zahlber Sekund Schüler	n. eichserv arstufen fehler, A	weiterung I, Rechne Aufbau vo	nze Zahlen, den Dir gen und Behandlun n können, Technolo n Grundvorstellung für die Entwicklung	g von ogiee gen, N	ı Gleichungen insatz, Teilbaı ∕löglichkeiter	und Teri rkeitsunt der Nut	men in ersuch zung v	den beid ungen; t on Strate	den ypische egien,
3	Einführ Die Stur erlanş beher veransc könne	dierende gen fach rrschen I chauliche en anhar entes Üb	ie elemer en liche Sich Darstellur en, spracl nd der in	ntare Zahlentheorie nerheit in schulrelev ngen und Konzepte nsensibel und binne den Übungen prakt egabtenförderung	vante , um endiff tiziert	n Aspekten d Themengebie erenzierend a ten zahlreiche	er Algebr ete der Al zu gestalt en Beispie	ra und gebra ten. ele Krit	Zahlenth in der Sc ærien für	ieorie. hule zu
4	Lineare			ipation ndlagen des Lehrer	is und	d Lernens vor	n Mathen	natik (1	ſeilnahm	e ohne
5	Final M	Module Passed) Module	kaminatic e Examin) e Examin	on: ation (Study Examin ation (Technical Exa n (Mündliche Prüfu	amina	ation, Special	Form, Du			

10	Comment
9	Literature A. Beck, M.N. Bleicher, D.W. Crowe: Excursions into Mathematics. Worth Publishers, Inc.1969. B.M.Steward: Theory of Numbers 2nd ed. The Macmillian Company. New York 1964 Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Malle, G. (1993). Didaktische Probleme der elementaren Algebra. Vieweg, Braunschweig/Wiesbaden. Gängige Schulbücher
8	Usability of the Module Mathematik: Lehramt
	 / Not Passed) Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
7	 Grading Final Module Examination: Module Examination (Study Examination, Homework, Worksheets, Weight: 0%, Passed
6	Prüferin/den Prüfer bekannt gegeben.) Requirements on the Award of Credit Points Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung. Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung (04-00-0039-se / Fachdidaktisches Seminar: Algebra in der Schule). Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z.B. von Erfahrungen mit Unterrichtsmethoden und -materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.
	Teils der Hausübungen. Die Anzahl sowie das Bewertungsschema der Hausübungen als Studienleistung wird während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben. Im Seminar in der Regel aktive Mitarbeit in den Seminarsitzungen und erfolgreiche Bearbeitung von Lernaufträgen wie z.B. Hausübungen oder ein Semesterprodukt. Die Kriterien diesbezüglich werden während des ersten Veranstaltungstermins durch die

Module nam	ne				
Semi	nar for subject	-specific didactics	: Algebra in scho	ols	
Module no.	Credit Points	Workload	Self-study	Duration	Frequency

04-3 053(-		3 CP	90 h		60 h	1 Semest	ter	Every 2	. semester		
Lang	guage of	Instruct	ion		Pers	on responsib	le for the	Mod	ule			
Geri	man				Prof.	. Dr. phil. nat.	Katja Krü	iger				
1	Course	s of the I	Module									
	Course no.		Course	name		Workload (CP)		Form of Teaching		Contact Hours per Week		
	04-00-0	039-se		for subject-specific : Algebra in schools		0		Semin	ar	2		
2	Sekund Teilbarl Möglicł	eichserv arstufen keitsunten nkeiten c	, Rechne ersuchun ler Nutzu	gen und Behandlun nkönnen, Einsatz d gen; typische Schül Ing von Strategien, Sekundarstufe II.	igitale erfeh	er Werkzeuge Ier, Aufbau v	, insb. Ge on Grund	eoGebra,				
	erlang behen veranso kön intellige Damit v	rrschen I chauliche nen anh entes Üb verden s	liche Sich Darstellu en, sprac and der a en erläu	nerheit in schulrelev ngen und Konzepte hsensibel und binne zahlreichen in den S tern und entwickelr igt, diese Methoder enden.	, um ⁻ endiff Semin n ihre	Themengebie erenzierend z aren diskutie diagnostisch	ete der Alg zu gestalt rten Beis e Kompet	gebra en. piele I cenz.	in der Sc Kriterien	hule zu für		
4	Require	ements f	or Partic	ipation								
5	Final M Fachpro Studien Semina	Module Module ifung: So leistung rsitzunge n Semes	aminatio e Examin e Examin onderforn : Sonderf en und e	ation (Technical Exa ation (Study Examin m (Mündliche Prüfu form (Im Seminar ir rfolgreiche Bearbei kt (z.B. Erstellung e	natior Ing m I der l tung v	n, Special Forn it Portfolioan Regel aktive N von Lernauftr	m, Passeo teilen) ⁄litarbeit ägen wie	d / No in der z.B. H	nt Passed N lausübur) Igen		

6	Requirements on the Award of Credit Points
	Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur
	Fachprüfung
	Erfolgreiche Teilnahme zu 75% an der Lehrveranstaltung [04-00-0039-se Fachdidaktisches Seminar: Algebra in der Schule].
	Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z. B. von Erfahrungen mit Unterrichtsmethoden und -materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.
7	Creding
/	Grading Final Module Examination:
	• Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
	 Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module
9	Literature
	Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer.
	Malle, G. (1993). Didaktische Probleme der elementaren Algebra. Vieweg, Weigand, H.G,
	Schüler-Meyer, A. und Pinkernell, G. (2022): Didaktik der Algebra. Springer
	Gängige Schulbücher
10	Comment

Mo	dule nan	ne								
	Semi	nar for	subject	-specific did	actics	: Analysis in	scho	ols		
04-3	dule no. 30- 1/de	Credit F	Points 3 CP	Workload	90 h	Self-study	60 h	Duration 1 Semester	Frequei Every 2	ncy . semester
	guage of man	Instruct	ion			•		le for the Mod Katja Krüger	ule	
1	Course	s of the l	Module							
	Course	no.	Course	name		Workl	oad (C	CP) Form Teac		Contact Hours per

					Week
	04-00-0159-se	Seminar for subject-specific didactics: Analysis in schools	0	Seminar	2
2	Riemannscher	ideutik, Funktionsuntersuchun Integralbegriff, Anwendungen Jen von Schüler*innen; Obersti satz	der Infinitisen	nalrechnung in der Sch	ule,
3	verschiedene Z beherrschen Einsatzes digita diskutieren in Förderung. Damit werden		ingen gegenei im Themengel der Schule zu ispiele für inte	nander abwägen. piete der Analysis - auc veranschaulichen. Iligentes Üben, Diagno	h mit Hilfe des se und
4	Requirements	for Participation s Lehrens und Lernens von Ma	thematik (Teil	nahme ohne Nachweis	
5	 Modul Fachprüfung: S Studienleistung Seminarsitzung oder ein Semes Förderempfehl 		tion, Special F g mit Portfolio ler Regel aktiv ng von Lernau es Lernvideos ch werden wäl	orm, Passed / Not Pas anteilen) e Mitarbeit in den fträgen wie z.B. Hausü oder einer diagnoseba nrend des ersten	sed) bungen
6	Bestehen der F Fachprüfung Erfolgreiche Te seminar: analys Die Anwesenhe Diskussionen u sowie didaktisc	on the Award of Credit Points achprüfung; Bestehen der Stud ilnahme zu 75% an der Lehrver sis in der schule]. eitspflicht ist für folgenden Kor nd Reflexionen z. B. von Erfahr hen Konzepten. Die Ziele der L den anderen Studierenden un	ranstaltung [/(npetenzerwer ungen mit Un ehrveranstaltu	04-00-0159-se fachdida b erforderlich: Fortwäh terrichtsmethoden und ung können vor allem d	iktisches irende I - materialien durch die

	Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.
7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematik: Lehramt
9	Literature Greefrath, G., Oldenburg, R., Siller, H. S., Ulm, V., Weigand, H. G.: Didaktik der Analysis. Wiesbaden: Springer-Verlag (2016). Tietze, UP., Klika,M., Wolpers, HH.: Mathematikunterricht in der SII, Bd. 1, Fachdidaktische Grundfragen, Didaktik der Analysis. Vieweg 2000, Büchter, A., Henn, HW.: Elementare Analysis: Von der Anschauung zur Theorie. Spektrum 2010. Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Gängige Schulbücher
10	Comment

Мо	dule nan	ne									
	Semi	nar for	subject	-specific didactics	: Stocl	hastic	s in s	chools			
04-	dule no. 30- 32/de	Credit	Points 3 CP	Workload 90 h	Self-s	tudy	60 h	Duratio 1 Semes		Freque Irregula	•
	guage of man	Instruc	tion			•		l e for th . Katja Kr		ıle	
1	Courses of the Module										
	Course no. Course			name		Work	load ((CP)	Form Teacł		Contact Hours per Week
	04-00-0	00-0160-se Seminar for subject-specific didactics: Stochastics in school				0 Is			Semina	ar	2
2	Study C Didakti			er Grundbegriffe dei	r Stoch	astik;	Reprä	sentatio	nen voi	n Daten;	; statistical

	literacy; Datenanalyse und Simulationen mit digitalen Werkzeugen, Wahrscheinlichkeitsmodelle und Standardverteilungen, Zufallsgrößen und ihre Momente, Satz von Bayes und Anwendungen, Schätzen (inklKonfidenzintervalle) und Testen
3	Learning Outcomes Die Studierenden haben tiefgründige Kenntnisse zu Entwicklung und Aspekten zentraler Begriffe der der Stochastik und beschreiben typische Verständnisschwierigkeiten beim Umgang mit ihnen beschreiben zu den zentralen Themenfeldern der Stochastik paradigmatische Beispiele, Grundvorstellungen und begriffliche Vernetzungen, u.a. durch fundamentale Ideen, typische Präkonzepte und Verstehenshürden, kennen wesentliche Elemente von (digitalen) Lernumgebungen für den Mathematikunterricht in den genannten Themenfeldern und nutzen diese zur zielgerichteten Konstruktion von Lerngelegenheiten in heterogenen Gruppen bewerten Bildungsstandards, Lehrpläne und Unterrichtsmedien (z.B. Schulbücher, Software) und nutzen sie reflektiert für die Unterrichtsgestaltung. Damit werden sie befähigt, diese Methoden und Medien im Mathematikunterricht adressaten- und sachgerecht anzuwenden.
4	Requirements for Participation Grundlagen des Lehrens und Lernens von Mathematik, Einführung in die Stochastik (Teilnahme ohne Nachweis möglich)
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Special Form, Duration 15 min, Standard) Module Examination (Study Examination, Special Form, Passed / Not Passed) Fachprüfung: Sonderform (Mündliche Prüfung mit Portfolioanteilen) Studienleistung: Sonderform (Im Seminar in der Regel aktive Mitarbeit in den Seminarsitzungen und erfolgreiche Bearbeitung von Lernaufträgen wie z.B. Hausübungen oder ein Semesterprodukt (z.B. Erstellung eines Lernvideos oder einer diagnosebasierten Förderempfehlung). Die Kriterien diesbezüglich werden während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.
6	 Requirements on the Award of Credit Points Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung Erfolgreiche Teilnahme zu 75% an der Lehrveranstaltung [/04-00-0160-se fachdidaktisches seminar: stochastik in der schule]. Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z. B. von Erfahrungen mit Unterrichtsmethoden und -materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.

7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Bassed)
8	Passed) Usability of the Module Mathematik: Lehramt
9	Literature R. Biehler, J. Engel: Stochastik: Leitidee Daten und Zufall. In R. Bruder, L. Hefendehl-Hebeker, B. Schmidt-Thieme, GG. Weigand (Hrsg.): Handbuch der Mathematikdidaktik, Springer Spektrum 2015, S. 221 -251. UP. Tietze, M. Klika, H. Wolpers: Mathematikunterricht in der Sekundarstufe II. Band 3: Didaktik der Stochastik. Vieweg 2002. K. Krüger, H.D. Sill und C. Sikora: Didaktik der Stochastik in der Sek I. Springer 2015
10	Comment

Mo	dule nam	ne									
	Semi	nar for	subject	-specific didactics	: Geo	metry	in scl	hools			
Module no. 04-30- 0533/de		Credit Points 3 CP		Workload 90 h		· · · · · · ,		Duration 1 Semester		Frequency Every 2. semester	
	guage of man	Instruct	ion			-		le for the . Katja Kri		ule	
1	Course	s of the	Module								
	Course no. Course name								Form Teach	-	Contact Hours per Week
	04-10-0	for subject-specific : Geometry in school	s	0			Semina	ar	2		
2	Experin Mather geomet Verwer	en Raum nentiere natik, fü trischen ndung vo	n und Ge r innerm Denkens n Darste	m, Messen, Geome estalten, für analysie athematisches und Raumvorstellung u Ilungen; Sprachlich ometrie-Software.	erend anwe und ra	es und endungs iumlich	begrü sbezog es Str	ndendes genes Pro ukturiere	Vorge bleml n, Beg	hen in de ösen und riffsbildu	Aspekte Ing,

3	Learning Outcomes							
	Die Studierenden sind in der Lage							
	geometrische Figuren plastisch sowie durch Zeichnungen und (auch digitalen) Konstruktionen							
	darzustellen							
	 geometrische Problemstellungen zu bearbeiten und verwendete Strategien zu reflektieren Produkte von Lernenden in Bezug auf Schwierigkeiten und Kompetenzen zu analysieren und fachliche Unterstützungsangebote zu erarbeiten 							
	Aufgaben- und Fachtexte in Bezug auf sprachliche Anforderungen zu analysieren							
	binnendifferenzierende Unterrichtsbausteine zu geometrischen Themen der SI und SII zu gestalten und zu präsentieren							
	Damit werden sie befähigt, diese Methoden und Medien im Mathematikunterricht adressaten- und sachgerecht anzuwenden.							
ŀ	Requirements for Participation							
	Grundlagen des Lehrens und Lernens von Mathematik (Teilnahme ohne Nachweis möglich)							
5	Form of Examination							
	Final Module Examination:							
	• Module Examination (Technical Examination, Special Form, Duration 15 min, Standard)							
	Module Examination (Study Examination, Special Form, Passed / Not Passed)							
	Fachprüfung: Sonderform (Mündliche Prüfung mit Portfolioanteilen)							
	Studienleistung: Sonderform (Im Seminar in der Regel aktive Mitarbeit in den							
	Seminarsitzungen und erfolgreiche Bearbeitung von Lernaufträgen wie z.B. Hausübungen							
	oder ein Semesterprodukt (z.B. Erstellung eines Lernvideos oder einer diagnosebasierten							
	Förderempfehlung). Die Kriterien diesbezüglich werden während des ersten							
	Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.							
5	Requirements on the Award of Credit Points							
	Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung							
	Erfolgreiche Teilnahme zu 75% an der Lehrveranstaltung [/04-10-0533-se fachdidaktisches							
	seminar: geometrie in der schule].							
	Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende							
	Diskussionen und Reflexionen z. B. von Erfahrungen mit Unterrichtsmethoden und -materialien							
	sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene							
	Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv							
	beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.							

	 Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematik: Lehramt
9	Literature Hattermann/Kadunz/Rezat/Sträßer: Leitidee Raum und Form. In Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Praxis der Mathematik in der Schule (Heft 45): Ausgesprochen Mathe – Sprachen fördern ml 196: Problemlösen lernen in der Geometrie, Seelze Friedrich (2016) Wiegand, H-G.; Filler, A.; Hölzl, R.; Kuntze, S.; Ludwig, M. / Roth, J.; Schmidt-Thieme, B.; Wittmann, G.: Didaktik der Geometrie für die Sekundarstufe I. 3. Auflage. Berlin: Springer Spektrum 2018
10	Comment

	Semi	nar for	<u>subje</u> ct	-specific didactics	: Digital Me	edia ir	n mather	natica	l lesso	ons
Module no. 04-30- 0534/de		PointsWorkload3 CP90 h		Self-study	tudy Duration 60 h 1 Semes				e ncy 2. semester	
	iguage of rman	Instruct	ion		Person res Prof. Dr. ph				ıle	
1	Course	s of the	Module							
	Course no.		Course name		Workl	Workload (CP)		Form of Teaching		Contact Hours per Week
	didad			for subject-specific s: Digital media in atical lessons	0			Semina	ar	2
2	Technis Tabelle	Study Content Technische Möglichkeiten, didaktische Konzepte und Anwendungsbeispiele zu Tabellenkalkulationsprogrammen, dynamischer Geometriesoftware, Computer- AlgebraSystemen, Programmierung und didaktischer Hardware								
3	Learnin	g Outco	mes							
	D C	dierende								

	 Module Examination (Technical Examination, Special Form, Weight: 100%, Standard)
7	 Grading Final Module Examination: Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
6	Requirements on the Award of Credit Points Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung. Erfolgreiche Teilnahme zu 75% an der Lehrveranstaltung [/04-00-0249-se fachdidaktisches seminar: medien in der schule]. Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z. B. von Erfahrungen mit Unterrichtsmethoden und - materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.
5	 Form of Examination Final Module Examination: Module Examination (Study Examination, Special Form, Passed / Not Passed) Module Examination (Technical Examination, Special Form, Duration 15 min, Standard) Fachprüfung: Sonderform (Mündliche Prüfung mit Portfolioanteilen) Studienleistung: Sonderform (Im Seminar in der Regel aktive Mitarbeit in den Seminarsitzungen und erfolgreiche Bearbeitung von Lernaufträgen wie z.B. Hausübungen oder ein Semesterprodukt (z.B. Erstellung eines Lernvideos oder einer diagnosebasierten Förderempfehlung). Die Kriterien diesbezüglich werden während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.
4	Requirements for Participation Grundlagen des Lehrens und Lernens von Mathematik, Mediendidaktik (aus dem Vernetzungsbereich) (Teilnahme ohne Nachweis möglich) Form of Examination
	 erlangen Grundkenntnisse in den gängigsten Mathematikprogrammkategorien, im Umgang mit Taschenrechnern, Tablets, interaktiven Whiteboards und im Programmieren. können Medienanwendungen mit unterschiedlichen didaktischen Konzepten begründen und entwickeln Damit werden sie befähigt, diese Medien im Mathematikunterricht adressaten- und sachgerecht anzuwenden.

9	Literature
	Relevante Beiträge aus Bruder et al (2015). Handbuch der Mathematikdidaktik. Springer. Barzel, B., Hußmann, S., Leuders, T. (2005): Computer, Internet Co. im MathematikUnterricht. Cornelsen Verlag Scriptor. Artikel aus "mathematik lehren" und gängige Schulbücher
10	Comment

Module no	Credit	Points	Workload			Duratio	uration Fr		requency		
04-30-0604	1	7 CP	210 h	150 h 1 Semes			ster Every 2. semes		2. semeste		
L anguage (German	of Instruc	tion		Person respo Prof. Dr. phil.				le			
1 Cours	Courses of the Module										
Cours	e no.	Course name		Workloa	Workload (CP)		Form of Teaching		Contact Hours per Week		
04-00	04-00-0055-se		Deepening and reflection		0		Seminar		2		
04-30	04-30-0044-se		Practical didactic school studies		0		Seminar		2		
daran Vertie	anschlief fungssem	Sende ninar beir	ktikum Mathematik hhalten die Reflexio orbenen und vertie	n des didaktisc	hen	Handelr	is anha	nd der	im		
daran Vertie Laufe Beoba Unter Die be ? Plar unter fachd sowie ? Rele	achdidakti anschlief fungssem des Studi achtung u richtsverl eiden Leh ung, Duro Einbindu idaktische die tiefgr vanz der	Sende hinar beir ums erw nd Analy äufen als rveransta chführun ng er und mo reifende a Diagnose		n des didaktisc ften Kenntniss ehr- und Lernp n. darüber hinaus Mathematiku te der Unterric g mit einem fac nrerprofession	hen e. Da oze: die nteri htsg hdic alitä	Handelr azu zähle ssen sow richt an o gestaltun daktische t, Methc	is anha en insbe vie einer b g und l en Schv oden zu	nd der esonder eruflich Literatu verpun	im re die nen Schule ir kt.		
daran Vertie Laufe Beoba Unter Die bo ? Plar unter fachd sowie ? Rele Lernp	inchdidakti anschlief fungssem des Studi achtung u richtsverl eiden Leh ung, Durc Einbindu idaktische die tiefgr vanz der rozess-un	Sende hinar beir ums erw nd Analy äufen als rveransta chführun ng er und me reifende a Diagnose d Lerner	nhalten die Reflexio orbenen und vertie se von fachlichen Le forschendes Lerne altungen umfassen o g und Reflexion von ethodischer Konzep Auseinandersetzung efähigkeit für die Lel gebnisdiagnostik, A	n des didaktisc ften Kenntniss ehr- und Lernp n. darüber hinaus Mathematiku te der Unterric g mit einem fac nrerprofession	hen e. Da oze: die nteri htsg hdic alitä	Handelr azu zähle ssen sow richt an o gestaltun daktische t, Methc	is anha en insbe vie einer b g und l en Schv oden zu	nd der esonder eruflich Literatu verpun	im re die nen Schule ir kt.		
daran Vertie Laufe Beoba Unter Die be ? Plar unter fachd sowie ? Rele Lernp 3 Learn Die St ? krite	ichdidakti anschlief fungssem des Studi achtung u richtsverl eiden Lehi ung, Duro Einbindu idaktische die tiefgr vanz der rozess-un ing Outco udierende erienbasie n und die	Sende ninar beir ums erw nd Analy äufen als rveransta chführun, ng er und me reifende A Diagnose d Lerner, omes en sind ir ert Untern eigene	nhalten die Reflexio orbenen und vertie se von fachlichen Le forschendes Lerne altungen umfassen o g und Reflexion von ethodischer Konzep Auseinandersetzung fähigkeit für die Lel	n des didaktisc ften Kenntniss ehr- und Lernp n. darüber hinaus Mathematiku te der Unterric g mit einem fac nrerprofession nalyse einzelne	hen e. Da oze: ntern htsg hdic alitä r Sc	Handelr azu zähle ssen sow richt an o gestaltun daktische t, Metho hüler*in	einer b g und l en Schv oden zu nenleis	nd der esonder eruflich Literatu verpun stungen	im re die nen Schul n kt.		

	fachdidaktischer Literatur Unterrichtsentwürfe mit didaktischer und methodischer Analyse verfassen. ? Schüler*innenleistungen zu diagnostizieren, indem sie Lernergebnisse oder -prozesse anhand von Kriterien beurteilen und bewerten sowie Feedback geben, individuelle Lernvoraussetzungen, typische Fehler und Fehlvorstellungen identifizieren sowie entsprechende Maßnahmen zur Initiierung zielgerichteter und produktiver Lernprozesse auswählen.
4	Requirements for Participation Grundlagen des Lehrens und Lernens von Mathematik, Grundpraktikum (Teilnahme ohne Nachweis möglich)
5	 Form of Examination Final Module Examination: Module Examination (Technical Examination, Special Form, Standard)
	 Module Examination (Study Examination, Special Form, Passed / Not Passed) Fachprüfung: Sonderform (benoteter Praktikumsbericht) Studienleistung: Sonderform (In der Regel aktive Mitarbeit in den Seminarsitzungen, erfolgreiche Bearbeitung von Lernaufträgen, Unterrichtsbesuch mit Reflexion, Fortführung des E-Portfolios aus den vorangegangenen Praxisphasen. Die Kriterien diesbezüglich werden während des ersten Veranstaltungstermins durch die Prüferin/den Prüfer bekannt gegeben.)
6	Requirements on the Award of Credit Points Bestehen der Fachprüfung; Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung Erfolgreiche Teilnahme zu 75% an den beiden Lehrveranstaltungen [/04-00-0044-se fachdidaktische schulpraktische studien] und [/04-00-0055-se vertiefung und reflexion]. Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende Diskussionen und Reflexionen z. B. von Erfahrungen mit Unterrichtsmethoden und -materialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor allem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzelnen.
7	 Grading Final Module Examination: Module Examination (Technical Examination, Special Form, Weight: 100%, Standard) Module Examination (Study Examination, Special Form, Weight: 0%, Passed / Not Passed)
8	Usability of the Module Mathematik: Lehramt an beruflichen Schulen

9	Literature Barzel, B., Holzäpfel, L., Leuders, T., Streit, C. (2011). Scriptor Praxis - Mathematik: Mathematik unterrichten: Planen, durchführen, reflektieren: Buch mit Kopiervorlagen. Cornelsen Verlag Scriptor. Kratz, H. (2011). Wege zu einem kompetenzorientierten Mathematikunterricht – Ein Studien- und Praxisbuch für die Sekundarstufe. Kallmeyer – Klett, Seelze. Meyer, H. (2004). Praxisbuch: Was ist guter Unterricht? Mit didaktischer Landkarte. Cornelsen Verlag Scriptor.
10	Comment

IVIC				Workload	Self-study Duration					-		
04-	30-0613		3 CP	90 h	30 h 1 Semester Every 2. semes							
	iguage of rman	Instruct	ion		Person responsible for the Module Prof. Dr. phil. nat. Katja Krüger							
1	Course Course	s of the no.	Module Course	name	Work	load (CP)	Form Teach		Contact Hours per Week		
			-	or subject-specific s: Problem solving	0	0		Project 4		4		
2	Probler - Überb - Lösen - Anfor	f und ve nlösen le lick übe von Pro derunge	ernen r einschl blemauf n an unt	gaben und Reflexion errichtsgeeignete P	gebnisse mit n von Heuris	Unte tiken	rrichtsbez	ug		tion		
3	 Problemlösen lernen Überblick über einschlägige Forschungsergebnisse mit Unterrichtsbezug Lösen von Problemaufgaben und Reflexion von Heuristiken Anforderungen an unterrichtsgeeignete Problemlöseaufgaben und eigene Konstruktion sowie Reflexion entsprechender Aufgaben Learning Outcomes Entwicklung von Handlungskompetenz zur Planung von Mathematikunterricht, in dem mathematische Problemlösungskompetenz erworben werden kann Erarbeitung und eigene Erprobung eines Konzeptes zum Problemlösen lernen, z.B. eines Knobelwettbewerbs, einer Heurismenschulung o.ä. 											

4	Paguiraments for Participation
4	Requirements for Participation
	Grundlagen des Lehrens und Lernens von Mathematik, Praxissemester
	(Teilnahme ohne Nachweis möglich)
5	Form of Examination
	Final Module Examination:[list] Module Examination (Technical Examination, Homework
	Assignment, Standard)[/list]
	Fachprüfung: Hausarbeit
	Studienleistung: Sonderform (In der Regel aktive Mitarbeit in den Seminarsitzungen,
	erfolgreiche Bearbeitung von Lernaufträgen sowie eine unterrichtspraktische Erprobung mit
	Schüler*innen und kontinuierliche Reflexionen in einem E-Portfolio. Die Kriterien
	diesbezüglich werden während des ersten Veranstaltungstermins durch die Prüferin/den
	Prüfer bekannt gegeben.)
6	Requirements on the Award of Credit Points
	Bestehen der Fachprüfung;
	Bestehen der Studienleistung als Zulassungsvoraussetzung zur Fachprüfung
	Erfolgreiche Teilnahme zu 75%* an der Lehrveranstaltung [/04-00-0043-pj fachdidakti-
	sches projekt: problemlösen lernen].
	Die Anwesenheitspflicht ist für folgenden Kompetenzerwerb erforderlich: Fortwährende
	Diskussionen und Reflexionen z. B. von Erfahrungen mit Unterrichtsmethoden und -ma-
	terialien sowie didaktischen Konzepten. Die Ziele der Lehrveranstaltung können vor al-
	lem durch die Interaktion mit den anderen Studierenden und den Lehrenden erreicht
	werden. Die eigene Anwesenheit sowie die Anwesenheit einer Mindestzahl von sich aktiv
	beteiligenden Teilnehmenden sind Voraussetzung für einen Kompetenzerwerb der Einzel-
	nen.
7	Grading
	Final Module Examination:
	Module Examination (Study Examination, Portfolio, Weight: 0%, Passed / Not Passed)
	• Module Examination (Technical Examination, Homework Assignment, Weight: 100%,
	Standard)
8	Usability of the Module
0	-
	Mathematik: Lehramt
9	Literature
10	Comment