

Subdivided Module Catalogue  
for the Subject  
**Mathematical Physics**  
as a Bachelor's with 1 major  
with the degree "Bachelor of Science"  
(180 ECTS credits)

Examination regulations version: 2009  
Responsible: Institute of Mathematics  
Responsible: Faculty of Physics and Astronomy

**Course of Studies - Contents and Objectives**

The Bachelor programme in Mathematical Physics is offered by the Department of Mathematics, jointly with the Faculty of Physics and Astronomy, with a total of currently (SS 2010) 9 resp. 13 chairs.

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

Through the course these skills which the students acquire provide the basic knowledge required for analyzing and solving subsequently the various problems they encounter, and in particular for obtaining a consecutive Bachelor-Masters degree. Therefore, the main emphasis is put on the comprehension of fundamental mathematical and physical notions and principles, the knowledge of a variety of methods, the development of analytical reasoning and abstraction, and the capacity of a qualitative understanding of complex structural interconnections, rather than a detailed quantitative knowledge of many facts in mathematics and physics.

For the Bachelor thesis the student should work on a thematic and temporally closely limited frame in order to carry out a special task in mathematical physics, using well-known procedures and scientific criteria under guidance but, to a large extent, independently.

The exam should ascertain whether the candidate overlooks the context of the basics in mathematical physics and possesses the ability to apply the corresponding scientific methods. The exam should lead to an internationally comparable degree in mathematical physics and provides the means for entry into the working world. In the framework of a consecutive Bachelor-Masters degree it may also be used as preparation for further Masters study.

Abbreviations used

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

Term: **SS** = summer semester, **WS** = winter semester

Methods of grading: **NUM** = numerical grade, **B/NB** = (not) successfully completed

Regulations: **(L)ASPO** = general academic and examination regulations (for teaching-degree programmes), **FSB** = subject-specific provisions, **SFB** = list of modules

Other: **A** = thesis, **LV** = course(s), **PL** = assessment(s), **TN** = participants, **VL** = prerequisite(s)

Conventions

Unless otherwise stated, courses and assessments will be held in German, assessments will be offered every semester and modules are not creditable for bonus.

Notes

Should there be the option to choose between several methods of assessment, the lecturer will agree with the module coordinator on the method of assessment to be used in the current semester by two weeks after the start of the course at the latest and will communicate this in the customary manner.

Should the module comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise stated below.

Should the assessment comprise several individual assessments, successful completion of the module will require successful completion of all individual assessments.

In accordance with

the general regulations governing the degree subject described in this module catalogue:

**ASPO2009**

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

**20-Jan-2011 (2011-12)**

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

## The subject is divided into

Abbreviation	Module title	ECTS credits	Method of grading	page
<b>Compulsory Courses (118 ECTS credits)</b>				
<b>Mathematics (59 ECTS credits)</b>				
10-M-PPM-o82-mo1	Propaedeutics of Mathematics	2	B/NB	46
10-M-ANA-o82-mo1	Analysis	17	NUM	7
10-M-LNA-o82-mo1	Linear Algebra	14	NUM	35
10-M-DFT-o82-mo1	Ordinary Differential Equations and Complex Analysis	13	NUM	25
10-M-GAP-o92-mo1	Geometric Analysis and Partial Differential Equations	13	NUM	31
<b>Physics (59 ECTS credits)</b> For students interested in participating in the FOKUS programme, module 11-TQM-F will replace module 11-TQM. Module component 11-TQM-F-2, which will prepare students for studying in the Master's programme FOKUS Physik (FOKUS Physics), will be offered in the form of a block course between the lecture periods of the winter and summer semesters (for students who took up studies in winter semester, block course will be offered between third and fourth subject semester).				
11-KP-o92-mo1	Classical Physics (Mechanics, Thermodynamics, Waves, Oscillations, Electricity, Magnetism and Optics)	16	NUM	85
11-STE-o92-mo1	Statistical Mechanics, Thermodynamics and Electrodynamics	16	NUM	116
11-TQM-o92-mo1	Theoretical Mechanics and Quantum Mechanics	16	NUM	128
11-TQM-F-o92-mo1	Theoretical Mechanics and Quantum Mechanics for FOKUS Students	16	NUM	130
11-P-PB-MP-o92-mo1	Practical Course Part B Mathematical Physics	6	B/NB	93
11-P-PA-o92-mo1	Practical Course A	5	B/NB	91
<b>Compulsory Electives (32 ECTS credits)</b>				
Students must achieve a minimum of 8 ECTS credits in each of the module areas Mathematik (Mathematics) and Physik (Physics). To achieve the remaining 16 ECTS credits, students are to complete additional modules in these two areas (any modules in the respective areas may be selected).				
<b>Mathematics</b>				
10-M-BSA-o72-mo1	Seminar in Analysis	5	NUM	10
10-M-BSL-o72-mo1	Seminar in Linear Algebra	5	NUM	16
10-M-BSE-o72-mo1	Seminar in Algebra	5	NUM	13
10-M-BSG-o72-mo1	Seminar in Geometry	5	NUM	15
10-M-BSZ-o72-mo1	Seminar in Number Theory	5	NUM	21
10-M-BSW-o72-mo1	Seminar in Ordinary Differential Equations	5	NUM	20
10-M-BSC-o72-mo1	Seminar in Complex Analysis	5	NUM	11
10-M-BSN-o72-mo1	Seminar in Numerical Mathematics	5	NUM	17
10-M-BSS-o72-mo1	Seminar in Stochastics	5	NUM	19
10-M-BSF-o72-mo1	Seminar in Functional Analysis	5	NUM	14
10-M-BSO-o72-mo1	Seminar in Operation Research	5	NUM	18
10-M-BSD-o72-mo1	Seminar in Discrete Mathematics	5	NUM	12
10-M-EDM-o72-mo1	Introduction to Discrete Mathematics	5	NUM	27
10-M-FAN-o72-mo1	Introduction to Functional Analysis	5	NUM	29
10-M-ORS-o72-mo1	Operations Research	5	NUM	44
10-M-NLD-o72-mo1	Non-Linear Dynamics	5	NUM	38
10-M-GEO-o82-mo1	Introduction to Geometry	8	NUM	33
10-M-ZAL-o82-mo1	Number Theory and Algebra	13	NUM	64
10-M-NM1-o82-mo1	Numerical Mathematics 1	8	NUM	40

10-M-ST1-o82-m01	Stochastics 1	8	NUM	57
10-M-NM2-o82-m01	Numerical Mathematics 2	5	NUM	42
10-M-ST2-o82-m01	Stochastics 2	5	NUM	59
10-M-VAN-o82-m01	Advanced Analysis	8	NUM	61
10-M-MWR-o92-m01	Modelling and Computational Science	8	NUM	37
<b>Physics</b> Students who took module 11-QAM or module 11-FKP will not be able to take module 11-KM. With regard to future participation in the Master's degree programme FOKUS Physik (Physics), students interested in participating in the FOKUS programme are recommended to take modules 11-KM and 11-KET.				
11-A4-o72-m01	Astrophysics	6	NUM	68
11-EPP-o92-m01	Introduction to Plasmaphysics	6	NUM	75
11-QM2-o92-m01	Quantum Mechanics II	8	NUM	101
11-QVTP-o92-m01	Many Body Quantum Theory	8	NUM	103
11-RMS-o92-m01	Relativistic Effects in Mesoscopic Systems	5	NUM	105
11-TFK-o92-m01	Theoretical Solid State Physics	8	NUM	122
11-TSL-o92-m01	Theory of Superconduction	5	NUM	132
11-PSK-o92-m01	Physics of Complex Systems	6	NUM	89
11-QIC-o92-m01	Quantum Information and Quantum Computing	5	NUM	99
11-SDC-o92-m01	Statistics, Data Analysis and Computer Physics	4	NUM	113
11-AKM-o92-m01	Cosmology	6	NUM	70
11-APL-o92-m01	Plasma-Astrophysics	6	NUM	72
11-GRT-o92-m01	Group Theory	6	NUM	79
11-NMA-o92-m01	Numerical Methods in Astrophysics	6	NUM	87
11-QFT2-o92-m01	Quantum Field Theory II	6	NUM	97
11-RNT-o92-m01	Renormalization Theory	6	NUM	107
11-RQFT-o92-m01	Relativistic Quantumfield Theory	8	NUM	109
11-RTT-o92-m01	Theory of Relativity	6	NUM	111
11-TEP-o92-m01	Theoretical Elementary Particle Physics	8	NUM	120
11-TPE-o92-m01	Experimental Particle Physics	4	NUM	124
11-TPS-o92-m01	Particle Physics (Standard Model)	8	NUM	126
11-SUS-o92-m01	Supersymmetry I and II	6	NUM	118
11-KM-o92-m01	Condensed Matter (Quanta, Atoms, Molecules, Solid State Physics)	16	NUM	83
11-KET-o92-m01	Nuclear and Elementary Particle Physics	4	NUM	82
11-AST-o92-m01	Theoretical Astrophysics	6	NUM	74
11-FKP-o92-m01	Solid State Physics 1	8	NUM	77
11-QAM-o92-m01	Quanta, Atoms, Molecules	8	NUM	95
<b>Thesis (10 ECTS credits)</b>				
10-M-BAP-o92-m01	Thesis Mathematical Physics (Bachelor Thesis)	10	NUM	9
<b>Subject-specific Key Skills</b>				
<b>Key Skills 1 (Compulsory) (5 ECTS credits)</b>				
10-M-VKM-o82-m01	Preparatory Course Mathematics	1	B/NB	63
11-SMP-o92-m01	Seminar Mathematical Physics	4	NUM	115
<b>Key Skills 2 (Elective)</b>				
Students may only take one out of the two modules 10-M-COM and 10-M-COMg or, respectively, out of the two modules 10-M-PRG and 10-M-PRGk.				
11-A4-o72-m01	Astrophysics	6	NUM	68
10-M-BSA-o72-m01	Seminar in Analysis	5	NUM	10
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10-M-BSL-072-m01	Seminar in Linear Algebra	5	NUM	16
10-M-BSE-072-m01	Seminar in Algebra	5	NUM	13
10-M-BSG-072-m01	Seminar in Geometry	5	NUM	15
10-M-BSZ-072-m01	Seminar in Number Theory	5	NUM	21
10-M-BSC-072-m01	Seminar in Complex Analysis	5	NUM	11
10-M-BSN-072-m01	Seminar in Numerical Mathematics	5	NUM	17
10-M-BSS-072-m01	Seminar in Stochastics	5	NUM	19
10-M-BSF-072-m01	Seminar in Functional Analysis	5	NUM	14
10-M-BSO-072-m01	Seminar in Operation Research	5	NUM	18
10-M-BSD-072-m01	Seminar in Discrete Mathematics	5	NUM	12
10-M-COMg-082-m01	Computational Mathematics, advanced	4	B/NB	24
10-M-PRGk-082-m01	Programming course for students of Mathematics and other subjects, simple	2	B/NB	49
10-M-RCN-082-m01	Reading Course Numerical Mathematics	4	NUM	52
10-M-RCS-082-m01	Reading Course Stochastics	4	NUM	55
10-M-RCD-082-m01	Reading Course Discrete Mathematics	4	NUM	50
10-M-RCF-082-m01	Reading Course Functional Analysis	4	NUM	51
10-M-RCO-082-m01	Reading Course Operations Research	4	NUM	53
10-M-RCY-082-m01	Reading Course Dynamical Systems	4	NUM	56
10-M-RCP-082-m01	Reading Course Optimisation	4	NUM	54
10-M-PRG-082-m01	Programming course for students of Mathematics and other subjects	3	B/NB	47
10-M-COM-082-m01	Computeroriented Mathematics	3	B/NB	22
11-HS-092-m01	Advanced Seminar Experimental/Theoretical Physics	4	NUM	81
11-A1-092-m01	Computational Physics	6	NUM	66

Module title		Abbreviation
Analysis		10-M-ANA-082-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
17	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	By way of exception, additional prerequisites are listed in the section on assessments.
<b>Contents</b>		
Real numbers and completeness, basic topological notions, convergence and divergence of sequences and series, power series, Taylor series, fundamental calculus in one and several variables (including inverse and implicit function theorem); fundamental integral calculus in one variable (Riemann integral and improper integrals).		
<b>Intended learning outcomes</b>		
The student knows and masters the essential methods and notions of analysis. He/She is able to perform easy mathematical arguments and present them adequately in written and oral form. He/She is acquainted with the central proof methods and concepts in analysis, their analytic background and geometric interpretation.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
This module comprises 3 module components. Information on courses will be listed separately for each module component. <ul style="list-style-type: none"> <li>10-M-ANA-1-082: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-ANA-2-082: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-ANA-P-082: M (no information on SWS (weekly contact hours) and course language available)</li> </ul>		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.		
<b>Assessment in module component 10-M-ANA-1-082:</b> Analysis 1 Analysis 1 <ul style="list-style-type: none"> <li>8 ECTS, Method of grading: (not) successfully completed</li> <li>a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Modules 10-M-VKM and 10-M-PPM are recommended.</li> </ul> <b>Assessment in module component 10-M-ANA-2-082:</b> Analysis 2 Analysis 2 <ul style="list-style-type: none"> <li>7 ECTS, Method of grading: (not) successfully completed</li> <li>a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Modules 10-M-VKM and 10-M-PPM are recommended; in addition, module component 10-M-ANA-1 is recommended for module component 10-M-ANA-2.</li> </ul> <b>Assessment in module component 10-M-ANA-P-082:</b> Examination in Analysis <ul style="list-style-type: none"> <li>2 ECTS, Method of grading: numerical grade</li> <li>oral examination of one candidate each (approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Only after successful completion of module components: Successful completion of any one of the module components 10-M-ANA-1, 10-M-ANA-1, 10-M-ANA-2, 10-M-ANA-2 is a prerequisite for participation in module component 10-M-ANA-P.</li> </ul>		
<b>Allocation of places</b>		
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<b>Additional information</b>
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
§ 73 (1) 1. Mathematik Analysis
<b>Module appears in</b>
Bachelor' degree (1 major) Computer Science (2010) Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)



Module title		Abbreviation
Thesis Mathematical Physics (Bachelor Thesis)		10-M-BAP-092-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
10	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Registration for assessment: as specified.
<b>Contents</b>		
Independently researching and writing on a (potentially interdisciplinary) topic in mathematics or physics selected in consultation with the supervisor.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given, possibly interdisciplinary topic in mathematics or physics and apply the skills and methods obtained during the study programme. He/She can write down the result of his/her work in a suitable form.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
(no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written thesis Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Mathematical Physics (2012)		

Module title		Abbreviation
Seminar in Analysis		10-M-BSA-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in analysis.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 1. Mathematik Analysis		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Seminar in Complex Analysis		10-M-BSC-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in complex analysis.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 1. Mathematik Analysis		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Seminar in Discrete Mathematics		10-M-BSD-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in discrete mathematics.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes)		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)		

Module title		Abbreviation
Seminar in Algebra		10-M-BSE-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in algebra.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Seminar in Functional Analysis		10-M-BSF-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in functional analysis.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes)		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)		

Module title		Abbreviation
Seminar in Geometry		10-M-BSG-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in geometry or differential geometry.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 4. Mathematik Geometrie		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Seminar in Linear Algebra		10-M-BSL-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in linear algebra.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		



Module title		Abbreviation
Seminar in Numerical Mathematics		10-M-BSN-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in numerical mathematics.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Seminar in Operation Research		10-M-BSO-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in operations research.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes)		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
--		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)		

Module title		Abbreviation
Seminar in Stochastics		10-M-BSS-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in stochastics.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 3. Mathematik Stochastik		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Seminar in Ordinary Differential Equations		10-M-BSW-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in the theory of ordinary differential equations.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 1. Mathematik Analysis		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Seminar in Number Theory		10-M-BSZ-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
A selected topic in number theory.		
<b>Intended learning outcomes</b>		
The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 60 minutes) Assessment offered: in the semester in which the course is offered Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
<b>Computeroriented Mathematics</b>		10-M-COM-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
3	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance of exercises (attendance monitored, a maximum of one incident of unexcused absence).
<b>Contents</b>		
Introduction to modern mathematical software for symbolic computation (e. g. Mathematica or Maple) and numerical computation (e. g. Matlab) to supplement the basic modules in analysis and linear algebra ((10-M-ANA or 10-M-ANL) and 10-M-LNA). Computer-based solution of problems in linear algebra, geometry, analysis, in particular differential and integral calculus; visualisation of functions.		
<b>Intended learning outcomes</b>		
The student learns the use of advanced modern mathematical software packages, and is able to assess their fields of application to solve mathematical problems.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
project in the form of programming exercises (as specified at the beginning of the course) Assessment offered: once a year, summer semester Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
<b>Module appears in</b>		
Bachelor' degree (1 major) Computer Science (2010) Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2009) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Physics (2008) Bachelor' degree (1 major) Technology of Functional Materials (2009) Bachelor' degree (1 major) Technology of Functional Materials (2010) Bachelor' degree (1 major) Nanostructure Technology (2010) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 22 / 133

Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Technology of Functional Materials (2010)  
 Master's degree (1 major) Technology of Functional Materials (2009)  
 Master's degree (1 major) Functional Materials (2012)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Computational Mathematics, advanced		10-M-COMg-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance of exercises (attendance monitored, a maximum of one incident of unexcused absence).
Contents		
Introduction to modern mathematical software for symbolic computation (e. g. Mathematica or Maple) and numerical computation (e. g. Matlab) to supplement the basic modules in analysis and linear algebra (10-M-ANA, 10-M-ANL and 10-M-LNA). Computer-based solution of problems in linear algebra, geometry, analysis, in particular differential and integral calculus; visualisation of functions.		
Intended learning outcomes		
The student learns the use of advanced modern mathematical software packages, and is able to assess their fields of application to solve mathematical problems.		
Courses (type, number of weekly contact hours, language — if other than German)		
Ü + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
project in the form of programming exercises (type and expenditure of time to be specified by the lecturer at the beginning of the course) Assessment offered: once a year, summer semester Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
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Additional information		
--		
Workload		
--		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
Module appears in		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Nanostructure Technology (2010) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Master's degree (1 major) Technology of Functional Materials (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		



Module title		Abbreviation
Ordinary Differential Equations and Complex Analysis		10-M-DFT-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
13	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	By way of exception, additional prerequisites are listed in the section on assessments.
Contents		
Existence and uniqueness theorems on solutions of ordinary differential equations, solution theorems on systems of linear differential equations, introduction to the problem of systems of nonlinear differential equations, basic notions in the qualitative theory of ordinary differential equations, basic properties of holomorphic functions, meromorphic functions and conformal maps, basic proof methods in differential equations and complex analysis, applications in computer science, physics, engineering science and other fields of mathematics.		
Intended learning outcomes		
The student is acquainted with the fundamental concepts and methods of the theory of ordinary differential equations and holomorphic functions. He/she is able to interconnect these concepts and realises the advantages of thinking across the borders of different branches in mathematics.		
Courses (type, number of weekly contact hours, language — if other than German)		
This module comprises 3 module components. Information on courses will be listed separately for each module component. <ul style="list-style-type: none"> <li>10-M-DFT-1-o82: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-DFT-2-o82: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-DFT-P-o82: M (no information on SWS (weekly contact hours) and course language available)</li> </ul>		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.		
<b>Assessment in module component 10-M-DFT-1-o82:</b> Ordinary Differential Equations Ordinary Differential Equations <ul style="list-style-type: none"> <li>4 ECTS, Method of grading: (not) successfully completed</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.</li> </ul>		
<b>Assessment in module component 10-M-DFT-2-o82:</b> Introduction to Complex Analysis Introduction to Complex Analysis <ul style="list-style-type: none"> <li>7 ECTS, Method of grading: (not) successfully completed</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> </ul>		
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- Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

**Assessment in module component 10-M-DFT-P-082:** Examination in Ordinary Differential Equations and Complex Analysis

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

#### Allocation of places

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#### Additional information

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#### Workload

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#### Teaching cycle

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

§ 73 (1) 1. Mathematik Analysis

#### Module appears in

Bachelor' degree (1 major) Mathematics (2008)  
Bachelor' degree (1 major) Economathematics (2009)  
Bachelor' degree (1 major) Economathematics (2008)  
Bachelor' degree (1 major) Mathematical Physics (2009)  
Bachelor' degree (1 major) Computational Mathematics (2009)  
Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Introduction to Discrete Mathematics		10-M-EDM-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Techniques from combinatorics, introduction to graph theory (including applications), cryptographic methods, error-correcting codes.		
Intended learning outcomes		
The student is acquainted with the fundamental concepts and results in discrete mathematics, masters the relevant proof techniques, is able to apply methods from number theory and algebra to discrete mathematics and realises the scope of applications of discrete structures.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
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Additional information		
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Workload		
--		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 2. Mathematik Lineare Algebra, Algebra und Elemente der Zahlentheorie		
Module appears in		
Bachelor' degree (1 major) Computer Science (2007) Bachelor' degree (1 major) Computer Science (2010) Bachelor' degree (1 major) Mathematics (2008)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 27 / 133

Bachelor' degree (1 major) Mathematics (2007)  
 Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Introduction to Functional Analysis		10-M-FAN-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Banach spaces and Hilbert spaces, bounded operators, principles of functional analysis.		
Intended learning outcomes		
The student knows the fundamental concepts and methods of functional analysis as well as the pertinent proof methods, is able to apply methods from linear algebra and analysis to functional analysis, and realises the broad applicability of the theory to other branches of mathematics.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
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Additional information		
--		
Workload		
--		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 1. Mathematik Analysis		
Module appears in		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Technology of Functional Materials (2009) Bachelor' degree (1 major) Technology of Functional Materials (2010)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 29 / 133

Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Master's degree (1 major) Technology of Functional Materials (2010)  
 Master's degree (1 major) Technology of Functional Materials (2009)  
 Master's degree (1 major) Functional Materials (2012)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)  
 Bachelor' degree (1 major) Technology of Functional Materials (2006)

Module title		Abbreviation
Geometric Analysis and Partial Differential Equations		10-M-GAP-092-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
13	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	By way of exception, additional prerequisites are listed in the section on assessments.
<b>Contents</b>		
Basics in analysis on manifolds, e. g. submanifolds and calculus of differential forms, Stoke's theorem and its applications in vector calculus and topology, examples of first order partial differential equations, existence and uniqueness theorems, basic equations in mathematical physics, boundary value theorems, maximum principle and Dirichlet problem.		
<b>Intended learning outcomes</b>		
The student knows and masters the basic notions and essential methods of vector analysis on manifolds and partial differential equations. He/She is able to perform mathematical arguments in this field independently, and can present them adequately in written and oral form. He/She is able to apply the central proof methods and concepts of geometric analysis and partial differential equations and knows about their analytic back-ground.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
This module comprises 3 module components. Information on courses will be listed separately for each module component. <ul style="list-style-type: none"> <li>10-M-GAP-1-092: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-GAP-2-092: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-GAP-P-092: M (no information on SWS (weekly contact hours) and course language available)</li> </ul>		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.		
<b>Assessment in module component 10-M-GAP-1-092:</b> Geometric Analysis Geometric Analysis <ul style="list-style-type: none"> <li>7 ECTS, Method of grading: (not) successfully completed</li> <li>a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Modules 10-M-ANA and 10-M-LNA are recommended.</li> </ul> <b>Assessment in module component 10-M-GAP-2-092:</b> Partial Differential Equations Partial Differential Equations <ul style="list-style-type: none"> <li>4 ECTS, Method of grading: (not) successfully completed</li> <li>a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Modules 10-M-ANA and 10-M-LNA are recommended.</li> </ul> <b>Assessment in module component 10-M-GAP-P-092:</b> Examination in Geometric Analysis and Partial Differential Equations <ul style="list-style-type: none"> <li>2 ECTS, Method of grading: numerical grade</li> <li>oral examination of one candidate each (approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Only after successful completion of module components: 10-M-GAP-1 or 10-M-GAP-2</li> <li>Other prerequisites: Modules 10-M-ANA and 10-M-LNA are recommended.</li> </ul>		

<b>Allocation of places</b>
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<b>Additional information</b>
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
Bachelor' degree (1 major) Mathematical Physics (2009)
Bachelor' degree (1 major) Computational Mathematics (2009)



Module title		Abbreviation
Introduction to Geometry		10-M-GEO-o82-mo1
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	By way of exception, additional prerequisites are listed in the section on assessments.
<b>Contents</b>		
Introduction to topics in geometry: axiomatic introduction of projective spaces, coordinates, fundamental theorems, relations to linear algebra and algebra, curves and hypersurfaces in Euclidean spaces, curvature.		
<b>Intended learning outcomes</b>		
The student is acquainted with the fundamental concepts and methods of geometry.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
This module has 2 components; information on courses listed separately for each component. <ul style="list-style-type: none"> <li>10-M-GEO-1-o82: V + Ü (no information on language and number of weekly contact hours available)</li> <li>10-M-GEO-2-o82: V + Ü (no information on language and number of weekly contact hours available)</li> </ul>		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
This module has the following 2 assessment components. To pass the module as a whole students must pass one of the two assessment components.		
<b>Assessment component to module component 10-M-GEO-1-o82: Einführung in die Projektive Geometrie</b> <ul style="list-style-type: none"> <li>8 ECTS credits, method of grading: numerical grade</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: English, German if agreed upon with the examiner</li> <li>Other prerequisites: Admission prerequisite to assessment: successful completion of approx. 50% of exercises. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.</li> </ul>		
<b>Assessment component to module component 10-M-GEO-2-o82: Einführung in die Differentialgeometrie</b> <ul style="list-style-type: none"> <li>8 ECTS credits, method of grading: numerical grade</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: English, German if agreed upon with the examiner</li> <li>Other prerequisites: Admission prerequisite to assessment: successful completion of approx. 50% of exercises. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.</li> </ul>		

<b>Allocation of places</b>
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<b>Additional information</b>
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
§ 73 (1) 4. Mathematik Geometrie
<b>Module appears in</b>
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Linear Algebra		10-M-LNA-o82-mo1
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
14	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	By way of exception, additional prerequisites are listed in the section on assessments.
<b>Contents</b>		
Sets, relations and maps; notions of groups, rings and fields (in particular, polynomial rings); vector spaces (subspaces, quotient spaces, linear independency, basis, dimension); linear maps (isomorphism theorem, image, kernel, rank); matrix calculus; systems of linear equations, determinants, eigenvalues, eigenvectors and eigenspaces, diagonalisability (including characteristic polynomial, minimal polynomial), normal forms, bilinear forms; Euclidean and unitary vector spaces (orthonormal bases, isometries, principal axis transformation).		
<b>Intended learning outcomes</b>		
The student knows and masters the basic notions and essential methods of linear algebra. He/She is able to perform easy mathematical arguments independently, and can present them adequately in written and oral form. He/She is able to apply the central proof methods and concepts of linear algebra and knows about their algebraic and geometric background.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
This module comprises 3 module components. Information on courses will be listed separately for each module component.		
<ul style="list-style-type: none"> <li>10-M-LNA-1-o82: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-LNA-2-o82: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-LNA-P-o82: M (no information on SWS (weekly contact hours) and course language available)</li> </ul>		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.		
<b>Assessment in module component 10-M-LNA-1-o82: Linear Algebra 1</b> Linear Algebra 1 <ul style="list-style-type: none"> <li>7 ECTS, Method of grading: (not) successfully completed</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.</li> </ul>		
<b>Assessment in module component 10-M-LNA-2-o82: Linear Algebra 2</b> Linear Algebra 2 <ul style="list-style-type: none"> <li>5 ECTS, Method of grading: (not) successfully completed</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> </ul>		

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

**Assessment in module component 10-M-LNA-P-o82:** Examination in Linear Algebra

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

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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

**Module appears in**

Bachelor' degree (1 major) Computer Science (2010)  
 Bachelor' degree (1 major) Mathematics (2008)  
 Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
<b>Modelling and Computational Science</b>		10-M-MWR-092-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Aspects of mathematical modelling of technical or scientific processes. Basic principles of modelling, aspects of scaling the modelling, asymptotic series, classical methods for solving ordinary and partial differential equations, fundamental methods for numerical solution of partial differential equations and the resulting systems of linear equations.		
<b>Intended learning outcomes</b>		
The student masters the fundamental mathematical methods and techniques to simulate processes from natural and engineering sciences on a computer.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes; usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes)		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Nanostructure Technology (2010) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		

Module title		Abbreviation
Non-Linear Dynamics		10-M-NLD-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
<b>Contents</b>		
Basic notions in stability theory, Lyapunov theory; stable manifolds, periodic solutions including Poincare-Bendixon, chaotic dynamics; applications in physics and biology (e. g. Hamiltonian systems, Volterra-Lotka).		
<b>Intended learning outcomes</b>		
The student is acquainted with the fundamental concepts and results in non-linear dynamics and their proof methods. He/She is able to apply these methods to simple situations, e.g. in physics or biology.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 1. Mathematik Analysis		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 38 / 133

Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Bachelor' degree (1 major) Aerospace Computer Science (2009)  
 Bachelor' degree (1 major) Aerospace Computer Science (2011)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Numerical Mathematics 1		10-M-NM1-082-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
<b>Contents</b>		
Solution of systems of linear equations and curve fitting problems, nonlinear equations and systems of equations, interpolation with polynomials, splines and trigonometric functions, numerical integration.		
<b>Intended learning outcomes</b>		
The student is acquainted with the fundamental concepts and methods in numerical mathematics, applies them to practical problems and knows about their typical fields of application.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
<b>Module appears in</b>		
Bachelor' degree (1 major) Computer Science (2010) Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2009)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 40 / 133



Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Physics (2008)  
 Bachelor' degree (1 major) Technology of Functional Materials (2009)  
 Bachelor' degree (1 major) Technology of Functional Materials (2010)  
 Bachelor' degree (1 major) Nanostructure Technology (2010)  
 Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Bachelor' degree (1 major) Aerospace Computer Science (2009)  
 Bachelor' degree (1 major) Aerospace Computer Science (2011)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Technology of Functional Materials (2010)  
 Master's degree (1 major) Technology of Functional Materials (2009)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) Functional Materials (2012)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Numerical Mathematics 2		10-M-NM2-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Solution methods and applications for eigenvalue problems, linear programming, initial value problems for ordinary differential equations, boundary value problems.		
Intended learning outcomes		
The student is able to draw a distinction between the different concepts of numerical mathematics and knows about their advantages and limitations concerning the possibilities of application in different fields of natural and engineering sciences and economics.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
Module appears in		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2009)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 42 / 133

Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Physics (2008)  
 Bachelor' degree (1 major) Technology of Functional Materials (2009)  
 Bachelor' degree (1 major) Technology of Functional Materials (2010)  
 Bachelor' degree (1 major) Nanostructure Technology (2010)  
 Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Bachelor' degree (1 major) Aerospace Computer Science (2009)  
 Bachelor' degree (1 major) Aerospace Computer Science (2011)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Technology of Functional Materials (2010)  
 Master's degree (1 major) Technology of Functional Materials (2009)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) Functional Materials (2012)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Operations Research		10-M-ORS-072-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Linear programming, duality theory, transport problems, integral linear programming, graph theoretic problems.		
Intended learning outcomes		
The student is acquainted with the fundamental methods in operations research, as required as a central tool for solving many practical problems especially in economics. He/She is able to apply these methods to practical problems, both theoretically and numerically.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
Module appears in		
Bachelor' degree (1 major) Computer Science (2007) Bachelor' degree (1 major) Computer Science (2010) Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematics (2007)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 44 / 133

Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Propaedeutics of Mathematics		10-M-PPM-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
2	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance of courses (as specified at the beginning of the course).
<b>Contents</b>		
Fundamental proof methods and questions in mathematics, insight into examples of abstract concepts of mathematics, e. g. by reference to its historical development, approach to axiomatic and deduction.		
<b>Intended learning outcomes</b>		
The student is acquainted with the basic proof methods and techniques in mathematics. He/She is able to perform easy mathematical arguments independently and present them adequately and reasonably in written and oral form.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
project assignments (type and expenditure of time to be specified by the lecturer at the beginning of the course) Assessment offered: once a year, winter semester Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Programming course for students of Mathematics and other subjects		10-M-PRG-o82-mo1
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
3	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance (attendance monitored, a maximum of one incident of unexcused absence).
<b>Contents</b>		
Basics of a modern programming language (e. g. C or Fortran) taking into account the particular needs in mathematics.		
<b>Intended learning outcomes</b>		
The student is able to work independently on small programming exercises and standard programming problems in mathematics.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
P (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
project in the form of programming exercises (as specified at the beginning of the course) Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2009) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Physics (2008) Bachelor' degree (1 major) Technology of Functional Materials (2009) Bachelor' degree (1 major) Technology of Functional Materials (2010) Bachelor' degree (1 major) Nanostructure Technology (2010) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Master's degree (1 major) Physics (2010) Master's degree (1 major) Technology of Functional Materials (2010) Master's degree (1 major) Technology of Functional Materials (2009)		
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Master's degree (1 major) Functional Materials (2012)  
Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
First state examination for the teaching degree Gymnasium Mathematics (2009)



Module title		Abbreviation
<b>Programming course for students of Mathematics and other subjects, simple</b>		10-M-PRGk-o82-mo1
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
2	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance (attendance monitored, a maximum of one incident of unexcused absence).
<b>Contents</b>		
Basics of a modern programming language (e. g. C or Fortran) taking into account the particular needs in mathematics.		
<b>Intended learning outcomes</b>		
The student is able to work independently on small programming exercises and standard programming problems in mathematics.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
P (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
project in the form of programming exercises (type and expenditure of time to be specified by the lecturer at the beginning of the course) Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
§ 73 (1) 5. Mathematik Angewandte Mathematik		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Nanostructure Technology (2010) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Reading Course Discrete Mathematics		10-M-RCD-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Basics in discrete mathematics.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
A (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		

Module title		Abbreviation
Reading Course Functional Analysis		10-M-RCF-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Basics in functional analysis.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
A (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
--		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		

Module title		Abbreviation
Reading Course Numerical Mathematics		10-M-RCN-082-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Advanced topics in numerical mathematics.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
A (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
--		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008)		
Bachelor' degree (1 major) Mathematical Physics (2009)		

Module title		Abbreviation
Reading Course Operations Research		10-M-RCO-082-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Basics in operations research.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
A (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
--		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		

Module title		Abbreviation
Reading Course Optimisation		10-M-RCP-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Basics in optimization.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
A (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
--		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		

Module title		Abbreviation
Reading Course Stochastics		10-M-RCS-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Advanced topics in stochastics.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
A (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)		
<b>Allocation of places</b>		
--		
<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
--		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		

Module title		Abbreviation
Reading Course Dynamical Systems		10-M-RCY-o82-mo1
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
<b>Contents</b>		
Basics in dynamical systems and nonlinear dynamics.		
<b>Intended learning outcomes</b>		
The student is able to work independently on a given scientific topic. He or she can tackle a simple mathematical text and can use standard literature.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
A (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) talk (approx. 30 minutes) or b) written elaboration (approx. 5 to 10 pages)		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		



Module title		Abbreviation
<b>Stochastics 1</b>		10-M-ST1-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Combinatorics, Laplace models, selected discrete distributions, elementary measure and integration theory, continuous distributions: normal distribution, random variable, distribution function, product measures and stochastic independence, elementary conditional probability, characteristics of distributions: expected value and variance, limit theorems: law of large numbers, central limit theorem.		
Intended learning outcomes		
The student is acquainted with fundamental concepts and methods in stochastics, applies these methods to practical problems and knows about the typical fields of application.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
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Additional information		
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Workload		
--		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 3. Mathematik Stochastik		
Module appears in		
Bachelor' degree (1 major) Computer Science (2010) Bachelor' degree (1 major) Mathematics (2008)		

Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
<b>Stochastics 2</b>		10-M-ST2-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Elements of data analysis, statistics of data in normal and other distributions, elements of multivariate statistics.		
Intended learning outcomes		
The student is acquainted with fundamental concepts and methods in statistics, applies these methods to practical problems and knows about the typical fields of application.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
--		
Additional information		
--		
Workload		
--		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 3. Mathematik Stochastik		
Module appears in		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Econometrics (2009) Bachelor' degree (1 major) Econometrics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009)		
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Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Advanced Analysis		10-M-VAN-o82-mo1
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Lebesgue integral in several variables, including theorems on convergence and Fubini's theorem, $L^p$ -spaces and elementary Fourier theory in $L^2$ , Gauss's theorem.		
Intended learning outcomes		
The student is acquainted with advanced topics in analysis. Taking the example of the Lebesgue integral, he or she is able to understand the construction of a complex mathematical concept.		
Courses (type, number of weekly contact hours, language — if other than German)		
Ü + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes) Language of assessment: German, English if agreed upon with the examiner		
Allocation of places		
--		
Additional information		
--		
Workload		
--		
Teaching cycle		
--		
Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 73 (1) 1. Mathematik Analysis		
Module appears in		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 61 / 133

Bachelor' degree (1 major) Computational Mathematics (2009)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Preparatory Course Mathematics		10-M-VKM-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
1	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance of courses (as specified at the beginning of the course).
<b>Contents</b>		
Introduction to the basic techniques in mathematics; approach to sets, propositions, propositional logic.		
<b>Intended learning outcomes</b>		
The student gets acquainted with the basic working techniques which are prerequisites for the further courses in the Bachelor's degree study programme.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
project assignments (type and expenditure of time to be specified by the lecturer at the beginning of the course) Assessment offered: once a year, winter semester Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
--		
<b>Workload</b>		
--		
<b>Teaching cycle</b>		
--		
<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
--		
<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2008) Bachelor' degree (1 major) Economathematics (2009) Bachelor' degree (1 major) Economathematics (2008) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Computational Mathematics (2009) Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008) First state examination for the teaching degree Gymnasium Mathematics (2009)		

Module title		Abbreviation
Number Theory and Algebra		10-M-ZAL-o82-m01
Module coordinator		Module offered by
Dean of Studies Mathematik (Mathematics)		Institute of Mathematics
ECTS	Method of grading	Only after succ. compl. of module(s)
13	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	By way of exception, additional prerequisites are listed in the section on assessments.
<b>Contents</b>		
Introduction to number theory, algebra and their interrelations: basic algebraic structures (groups, rings, fields); discussion of properties of integers and rational numbers (as well as algebraic extensions) with regard to their algebraic structure (residue class rings and finite fields).		
<b>Intended learning outcomes</b>		
The student is acquainted with the fundamental concepts and methods of number theory and algebra. He/she is able to interrelate these concepts and realises the advantages of thinking across the borders of different branches in mathematics.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
This module comprises 3 module components. Information on courses will be listed separately for each module component. <ul style="list-style-type: none"> <li>10-M-ZAL-1-o82: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-ZAL-2-o82: V + Ü (no information on SWS (weekly contact hours) and course language available)</li> <li>10-M-ZAL-P-o82: M (no information on SWS (weekly contact hours) and course language available)</li> </ul>		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.		
<b>Assessment in module component 10-M-ZAL-1-o82:</b> Introduction to Number Theory Introduction to Number Theory <ul style="list-style-type: none"> <li>4 ECTS, Method of grading: (not) successfully completed</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.</li> </ul>		
<b>Assessment in module component 10-M-ZAL-2-o82:</b> Introduction to Algebra Introduction to Algebra <ul style="list-style-type: none"> <li>7 ECTS, Method of grading: (not) successfully completed</li> <li>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</li> <li>Language of assessment: German, English if agreed upon with the examiner</li> <li>Other prerequisites: Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have</li> </ul>		
Bachelor's with 1 major Mathematical Physics (2009)		page 64 / 133



obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

**Assessment in module component 10-M-ZAL-P-082:** Examination in Number Theory and Algebra

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

**Allocation of places**

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**Additional information**

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**Workload**

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**Teaching cycle**

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

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

**Module appears in**

Bachelor' degree (1 major) Mathematics (2008)  
 Bachelor' degree (1 major) Economathematics (2009)  
 Bachelor' degree (1 major) Economathematics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2009)  
 Bachelor's degree (1 major, 1 minor) Mathematics (Minor, 2008)  
 First state examination for the teaching degree Gymnasium Mathematics (2009)

Module title		Abbreviation
Computational Physics		11-A1-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
<ul style="list-style-type: none"> <li>- Introduction to programming on the basis of C++ / Java / Mathematica</li> <li>- numerical solution of differential equations</li> <li>- simulation of chaotic systems</li> <li>- generation of random numbers</li> <li>- random walk</li> <li>- many-particle processes and reaction diffusion model</li> </ul>		
Intended learning outcomes		
The students have knowledge of two major programming languages and know algorithms important for Physics. They have knowledge of numerical standard methods and are able to apply computer-assisted processes to the solution of physical problems, e.g. algorithms for solving numerical problems of Physics.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 120 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.		
Allocation of places		
Only as part of pool of general key skills (ASQ): 15 places. Places will be allocated by lot.		
Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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### Module appears in

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Nanostructure Technology (2010)  
 Bachelor' degree (1 major) Nanostructure Technology (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

Module title		Abbreviation
Astrophysics		11-A4-072-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: successful completion of approx. 50% of exercises. Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
History of astronomy, coordinates and time measurement, the solar system, size scales in outer space, telescopes and detectors, stellar structure, stellar atmospheres, stellar evolution, final stages of stellar evolution, interstellar medium, structure of the Milky Way, local universe, expanding space-time, galaxies, active galactic nuclei, large-scale structure of the universe, Friedmann World Models, thermodynamics of the early universe, primordial nucleosynthesis, cosmic microwave background radiation, structure formation, inflation		
Intended learning outcomes		
The students are familiar with the modern world view of Astrophysics. They know methods and tools for astrophysical observations and evaluations. They are able to use these methods to plan and analyse own observations. They know the structure of the universe, e.g. of stars and galaxies and understand the process of their development.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + S (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 120 minutes)		
Allocation of places		
Only as part of pool of general key skills (ASQ): 15 places. Places will be allocated by lot.		
Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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Module appears in		

Bachelor' degree (1 major) Physics (2007)  
 Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2009)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Physics (2008)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Bachelor' degree (1 major) Aerospace Computer Science (2011)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)  
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2008)  
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

Module title		Abbreviation
Cosmology		11-AKM-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Expanding space-time, Friedmannian cosmology, basics of general relativity, the early universe, inflation, dark matter, primordial nucleosynthesis, cosmic microwave background, structure formation, supercluster, galaxies and galaxy clusters, intergalactic medium, cosmological parameters		
Intended learning outcomes		
The students have basic knowledge of cosmology. They know the theoretical methods of cosmology and are able to relate them to observations. They have gained insights into current research topics and are able to work on scientific questions.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Plasma-Astrophysics		11-APL-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Plasma Astrophysics: Dynamics of charged particles in electric and magnetic fields. Transport equations for energetic particles. Properties of magnetic turbulence. Propagation of solar particles within the solar wind. Particle acceleration via shock waves and via interaction with plasma turbulence. Particle acceleration and transport in galaxies and other cosmic objects.		
Intended learning outcomes		
The students have basic knowledge of Plasma Astrophysics. They have mastered the theoretical description of motion and acceleration of charged particles in space, they know corresponding measuring methods and can compare and evaluate theory and experiments.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Theoretical Astrophysics		11-AST-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	--
Contents		
Theoretical Astrophysics, models for the description of complex observation results, numeric simulations.		
Intended learning outcomes		
The students have basic knowledge of the methods of Theoretical Astrophysics. They are able to design complex observations and to test the models with the help of simulations.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 120 minutes)		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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Module appears in		
Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Mathematical Physics (2012) Master's degree (1 major) Physics (2010) Master's degree (1 major) Physics (2011) Master's degree (1 major) Mathematical Physics (2012) Master's degree (1 major) FOKUS Physics (2010) Master's degree (1 major) FOKUS Physics (2011) Master's degree (1 major) FOKUS Physics (2006)		

Module title		Abbreviation
Introduction to Plasmaphysics		11-EPP-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Plasma Astrophysics: Dynamics of charged particles in electric and magnetic fields, Magnetohydrodynamics, Transport equations for energetic particles, Properties of magnetic turbulence, Propagation of solar particles within the solar wind, Particle acceleration via shock waves and via interaction with plasma turbulence, Particle acceleration and transport in galaxies and other astrophysical objects, Cosmic radiation.		
Intended learning outcomes		
The students know the principles of Plasma Physics, especially the description of transport phenomena in plasma. They are able to solve basic problems of Plasma Physics and to apply this knowledge to Astrophysics.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + R (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Solid State Physics 1		11-FKP-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
<b>Contents</b>		
Physical laws of solids: Bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas).		
<b>Intended learning outcomes</b>		
The students understand the basic contexts and principles of solids (bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas)).		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 120 minutes, for modules with less than 4 ECTS credits approx. 90 minutes; unless otherwise specified) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematics (2012) Bachelor' degree (1 major) Mathematics (2013) Bachelor' degree (1 major) Mathematical Physics (2009)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 77 / 133

Bachelor' degree (1 major) Mathematical Physics (2012)  
 Bachelor' degree (1 major) Computational Mathematics (2012)  
 Bachelor' degree (1 major) Computational Mathematics (2013)  
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

Module title		Abbreviation
Group Theory		11-GRT-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Group theory. Finite groups. Lie groups. Lie algebra. Depiction. Tensors. Classification theorem. Applications.		
Intended learning outcomes		
The students know the basics of group theory, especially of Lie groups. They are able to identify problems of group theory and to solve them by using the acquired methods. They are able to apply group theory to the formulation and processing of physical problems.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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Module appears in		
Bachelor's with 1 major Mathematical Physics (2009)		
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Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)



Module title		Abbreviation
Advanced Seminar Experimental/Theoretical Physics		11-HS-092-m01
Module coordinator		Module offered by
Managing Directors of the Institute of Applied Physics and the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance and successful preparation of seminar presentation.
<b>Contents</b>		
Current issues of Theoretical/Experimental Physics.		
<b>Intended learning outcomes</b>		
The students have advanced knowledge of a specialist field of Experimental or Theoretical Physics. They are able to independently acquire this knowledge and to summarise it in an oral presentation.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk (approx. 30 to 45 minutes) with discussion Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)		

Module title		Abbreviation
Nuclear and Elementary Particle Physics		11-KET-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Physical laws of Nuclear and Elementary Particle Physics. Historical introduction. Scattering and spectroscopy. Nuclear models. Radioactive decay. Structure of nuclei. Nuclear energy. Quantum theoretical description of particles. Symmetries. Particle accelerators and detectors. Weak interaction. Strong interaction, quarks. Standard model. Current results.		
Intended learning outcomes		
The students understand the basic connections between fundamental Nuclear and Elementary Particle Physics. They have an overview of the experimental observations of Particle Physics and the theoretical models which describe them.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 120 minutes, for modules with less than 4 ECTS credits approx. 90 minutes; unless otherwise specified)		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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Module appears in		
Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)		

Module title		Abbreviation
<b>Condensed Matter (Quanta, Atoms, Molecules, Solid State Physics)</b>		11-KM-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
16	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	--
Contents		
Quantum phenomena, introduction to Atomic Physics and physical laws of solids. Experimental principles of Quantum Physics. Mathematical formulation of quantum mechanics. Quantum mechanics of hydrogen atoms. Atoms in external fields. Many-electron atoms. Optical transitions and spectroscopy. Laser. Molecules and chemical bonding. Molecule rotations and vibrations. Bonding in crystals. Mechanical properties. Free electron gas (FEG). Crystal structure. The reciprocal lattice. Structure determination. Lattice vibrations (phonons). Thermal properties of insulators. Electrons in a periodic potential.		
Intended learning outcomes		
The students know the basic contexts and principles of quantum phenomena, Atomic Physics and solids (bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas)). They are able to apply mathematical methods to the formulation of modern physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.		
Courses (type, number of weekly contact hours, language — if other than German)		
Kondensierte Materie 1 (Quanten, Atome, Moleküle) (Condensed Matter 1 (Quanta, Atoms, Molecules)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester) Kondensierte Materie 2 (Festkörperphysik 1) (Condensed Matter 2 (Solid State Physics)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>This module has the following assessment components</p> <ol style="list-style-type: none"> <li>Topics covered in lectures and exercises in part 1 (Kondensierte Materie 1 (Condensed Matter 1)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in part 2 (Kondensierte Materie 2 (Condensed Matter 2)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in parts 1 and 2: oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).</li> </ol> <p>Assessment component 3 will be offered in German; English if agreed upon with examiner(s). Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2. To qualify for admission to assessment component 3, students must pass assessment component 1 and/or 2. Students are highly recommended to attend both courses Kondensierte Materie 1 (Condensed Matter 1) and Kondensierte Materie 2 (Condensed Matter 2). The topics discussed in these two courses will be covered in assessment component 3. Students must register for assessment components 1 through 3 online (details to be announced). To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 3. The grade achieved in assessment component 1 or 2 (whichever is better) and the grade achieved in assessment component 3 will each count 50% towards the overall grade awarded for the module.</p>		
Allocation of places		
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Additional information		
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
Bachelor' degree (1 major) Mathematics (2012) Bachelor' degree (1 major) Mathematics (2013) Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Nanostructure Technology (2010) Bachelor' degree (1 major) Nanostructure Technology (2012) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Mathematical Physics (2012) Bachelor' degree (1 major) Computational Mathematics (2012) Bachelor' degree (1 major) Computational Mathematics (2013) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

Module title			Abbreviation
Classical Physics (Mechanics, Thermodynamics, Waves, Oscillations, Electricity, Magnetism and Optics)			11-KP-092-m01
Module coordinator		Module offered by	
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy	
ECTS	Method of grading	Only after succ. compl. of module(s)	
16	numerical grade	--	
Duration	Module level	Other prerequisites	
2 semester	undergraduate	Bridge course Mathematische Rechenmethoden der Physik (Mathematical Methods of Physics) for first-semester students.	
Contents			
Physical laws of mechanics, thermodynamics, vibrations, waves, science of electricity, magnetism, electromagnetic vibrations and waves, radiation and wave optics. Time, room and motion. Physical values. Force and motion. Interactions and central forces. General relativity. Mechanics of rigid bodies. Friction. Vibration and waves. Non-linearity and chaos. Mechanics of non-rigid bodies. Gasses. Thermodynamics. Electrostatics. Electric current. Mechanisms of conduction. Magnetostatics. Electromagnetic induction. Maxwell equations. Science of alternating current. Electromagnetic waves. Geometric optics. Wave optics.			
Intended learning outcomes			
The students understand the basic principles and connections of mechanics, thermodynamics, vibrations, waves, science of electricity, magnetism, electromagnetic vibrations and waves, radiation and wave optics. They are able to apply mathematical methods to the formulation of physical contexts and autonomously apply their knowledge to the solution of mathematical-physical tasks.			
Courses (type, number of weekly contact hours, language — if other than German)			
Klassische Physik 1 (Mechanik, Wellen, Wärme) (Classical Physics 1 (Mechanics, Waves, Heat)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester) Klassische Physik 2 (Elektromagnetismus, Optik) (Classical Physics 2 (Electromagnetism, Optics)): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)			
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)			
This module has the following assessment components 1. Topics covered in lectures and exercises in part 1 (Klassische Physik 1 (Classical Physics 1)): written examination (approx. 120 minutes). 2. Topics covered in lectures and exercises in part 2 (Klassische Physik 2 (Classical Physics 2)): written examination (approx. 120 minutes). 3. Topics covered in lectures and exercises in parts 1 and 2: oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).  Assessment component 3 will be offered in German; English if agreed upon with examiner(s). Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2. To qualify for admission to assessment component 3, students must pass assessment component 1 and/or 2. Students are highly recommended to attend both courses Klassische Physik 1 (Classical Physics 1) and Klassische Physik 2 (Classical Physics 2). The topics discussed in these two courses will be covered in assessment component 3. Students must register for assessment components 1 through 3 online (details to be announced). To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 3. The grade achieved in assessment component 1 or 2 (whichever is better) and the grade achieved in assessment component 3 will each count 50% towards the overall grade awarded for the module.			
Allocation of places			
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<b>Additional information</b>
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
<p>Bachelor' degree (1 major) Mathematics (2012)</p> <p>Bachelor' degree (1 major) Mathematics (2013)</p> <p>Bachelor' degree (1 major) Physics (2010)</p> <p>Bachelor' degree (1 major) Physics (2012)</p> <p>Bachelor' degree (1 major) Nanostructure Technology (2010)</p> <p>Bachelor' degree (1 major) Nanostructure Technology (2012)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2009)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2012)</p> <p>Bachelor' degree (1 major) Computational Mathematics (2012)</p> <p>Bachelor' degree (1 major) Computational Mathematics (2013)</p> <p>Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)</p> <p>No final examination Special study offering (2010)</p>

Module title		Abbreviation
Numerical Methods in Astrophysics		11-NMA-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Various methods used in astrophysical simulations with special emphasis on their applications. N-body algorithms (tree- and polynomial codes). Particle-mesh methods (particle-in-cell methods). Vlasow methods (e.g., Lattice-Boltzmann). Hyperbolic conservation laws (fluid dynamics, finite difference method, Riemann solver, ENO). Methods of high-performance computing. Message-passing interface (MPI). GPGPU programming (OpenCL).		
Intended learning outcomes		
The students are able to solve typical problems and equations of Astrophysics and other subdisciplines of Physics with the help of numerical simulations. They are especially capable of choosing adequate strategies to approach such problems and of validating the results.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 87 / 133

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

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
Bachelor' degree (1 major) Mathematical Physics (2009)  
Master's degree (1 major) Mathematics (2010)  
Master's degree (1 major) Physics (2010)  
Master's degree (1 major) FOKUS Physics (2010)



Module title		Abbreviation
Physics of Complex Systems		11-PKS-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
<ol style="list-style-type: none"> <li>1. Theory of critical phenomena in thermal equilibrium</li> <li>2. Introduction into the physics out of equilibrium</li> <li>3. Entropy production and fluctuations</li> <li>4. Phase transitions away from equilibrium</li> <li>5. Universality</li> <li>6. Spin glasses</li> <li>7. Theory of neural networks</li> </ol>		
Intended learning outcomes		
The students have specific and advanced knowledge in the field of physics of complex systems. They know the methods of Statistical Physics, Computational Physics and non-linear dynamics, which are used to describe such systems. They are able to work on current research problems in this area.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)</p> <p>Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.</p> <p>Language of assessment: German, English</p>		
Allocation of places		
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Additional information		
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Workload		
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
<p>Bachelor' degree (1 major) Physics (2010)</p> <p>Bachelor' degree (1 major) Physics (2012)</p> <p>Bachelor' degree (1 major) Nanostructure Technology (2012)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2009)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2012)</p> <p>Master's degree (1 major) Mathematics (2010)</p> <p>Master's degree (1 major) Physics (2010)</p> <p>Master's degree (1 major) Physics (2011)</p> <p>Master's degree (1 major) Nanostructure Technology (2011)</p> <p>Master's degree (1 major) Nanostructure Technology (2010)</p> <p>Master's degree (1 major) Mathematical Physics (2012)</p> <p>Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)</p> <p>Master's degree (1 major) FOKUS Physics (2010)</p> <p>Master's degree (1 major) FOKUS Physics (2011)</p>

Module title		Abbreviation
Practical Course A		11-P-PA-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
5	(not) successfully completed	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
Physical laws of mechanics, thermodynamics, science of electricity, types of error, error approximation and propagation, graphs, linear regression, average values and standard deviation, distribution functions, significance tests, writing of lab reports and publications.		
Intended learning outcomes		
The students know and have mastered physical measuring methods and experimenting techniques. They are able to independently plan and conduct experiments, to cooperate with others, and to document the results in a measuring protocol. They are able to evaluate the measuring results on the basis of error propagation and of the principles of statistics and to draw, present and discuss the conclusions.		
Courses (type, number of weekly contact hours, language — if other than German)		
Auswertung von Messungen und Fehlerrechnung (Measurements and Data Analysis): V (1 weekly contact hour) + Ü (1 weekly contact hour), once a year (winter semester) Beispiele aus Mechanik, Wärmelehre und Elektrik (Examples from Mechanics, Thermodynamics and Electricity, BAM): P (2 weekly contact hours)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>This module has the following assessment components</p> <ol style="list-style-type: none"> <li>Topics covered in lectures and exercises: written examination (approx. 120 minutes)</li> <li>Lab course: a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. b) Talk (with discussion) to test the students' understanding of the physics-related contents of the course (approx. 30 minutes).</li> </ol> <p>Successful completion of approx. 50% of practice work is a prerequisite for admission to assessment component 1.</p> <p>To pass assessment component 2, students must pass both elements a) and b). Students will be offered one opportunity to retake element a) and/or element b).</p> <p>Students must register for assessment components 1 and 2 online (details to be announced).</p> <p>Students must attend Auswertung von Messungen und Fehlerrechnung (Measurements and Data Analysis) before attending Beispiele aus Mechanik, Wärmelehre und Elektrik (Examples from Mechanics, Thermodynamics and Electricity).</p> <p>To pass this module, students must pass both assessment component 1 and assessment component 2.</p>		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 53 (1) 1. a) Physik Mechanik, Wärmelehre, Elektrizitätslehre, Optik, der speziellen Relativitätstheorie		
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§ 53 (1) 1. c) Physik physikalische Grundpraktika

§ 77 (1) 1. d) Physik "physikalische Praktika"

**Module appears in**

Bachelor' degree (1 major) Mathematics (2014)  
 Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Nanostructure Technology (2010)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Computational Mathematics (2014)  
 Bachelor' degree (1 major) Aerospace Computer Science (2009)  
 Bachelor' degree (1 major) Aerospace Computer Science (2014)  
 Bachelor' degree (1 major) Aerospace Computer Science (2011)  
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)  
 No final examination Special study offering (2010)

Module title		Abbreviation
<b>Practical Course Part B Mathematical Physics</b>		11-P-PB-MP-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	(not) successfully completed	11-P-PA
Duration	Module level	Other prerequisites
1 semester	undergraduate	--
Contents		
Physical laws of mechanics, thermodynamics, optics, science of electricity, vibration and waves, Atomic and Nuclear Physics, wave optics. Basic measuring methods using computers and storage oscilloscopes.		
Intended learning outcomes		
The students have knowledge and skills of physical measuring instruments and experimental techniques. They are able to independently plan and conduct experiments in cooperation with others, and to document the results in a measurement protocol.		
Courses (type, number of weekly contact hours, language — if other than German)		
Klassische Physik (Classical Physics, KLP): P (2 weekly contact hours) Elektrizitätslehre und Schaltungen (Electricity and Circuits, ELS): P (2 weekly contact hours) Wellenoptik (Physical Optics, WOP): P (2 weekly contact hours) Atom- und Kernphysik (Atomic and Nuclear Physics, AKP): P (2 weekly contact hours) Computer und Messtechnik (Computers and Measurement Technology, CMT): P (2 weekly contact hours)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
This module has the following assessment components 1. Lab course in part 1: a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. b) Talk (with discussion) to test the students' understanding of the physics-related contents of the course (approx. 30 minutes). 2. Lab course in part 2: a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. b) Talk (with discussion) to test the students' understanding of the physics-related contents of the course (approx. 30 minutes).  Students must register for assessment components 1 and 2 online (registration deadline to be announced). Students will be offered one opportunity to retake element a) and/or element b). To pass an assessment component, they must pass both elements a) and b). To pass this module, students must successfully complete two out of the five courses. Students must take exactly one course each in the areas KLP and ELS as well as one course in the areas WOP, AKP and CMT. Students must attend KLP or ELS courses prior to attending WOP, AKP or CMT courses. To pass this module, students must pass both assessment component 1 and assessment component 2.		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
§ 53 (1) 1. a) Physik Mechanik, Wärmelehre, Elektrizitätslehre, Optik, der speziellen Relativitätstheorie § 53 (1) 1. b) Physik Aufbau der Materie		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 93 / 133

§ 53 (1) 1. c) Physik physikalische Grundpraktika  
§ 77 (1) 1. b) Physik "Fortgeschrittene Experimentalphysik"  
§ 77 (1) 1. d) Physik "physikalische Praktika"

**Module appears in**

Bachelor' degree (1 major) Mathematical Physics (2009)

Module title		Abbreviation
Quanta, Atoms, Molecules		11-QAM-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Physical laws of Atomic, Quantum and Molecular Physics.		
Intended learning outcomes		
The students have knowledge of the basic contexts and principles of Atomic and Molecular Physics (atoms: Quantum mechanical atom model, one/multi-electron atoms, electronic dipole transitions, atoms in B field, as well as molecules: Bonding models and elementary excitations: rotations, vibrations, electronic excitations)		
Courses (type, number of weekly contact hours, language — if other than German)		
Ü + Ü (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
written examination (approx. 120 minutes, for modules with less than 4 ECTS credits approx. 90 minutes; unless otherwise specified) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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Module appears in		
Bachelor' degree (1 major) Mathematics (2012) Bachelor' degree (1 major) Mathematics (2013) Bachelor' degree (1 major) Mathematical Physics (2009)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 95 / 133

Bachelor' degree (1 major) Mathematical Physics (2012)  
 Bachelor' degree (1 major) Computational Mathematics (2012)  
 Bachelor' degree (1 major) Computational Mathematics (2013)  
 Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)



Module title		Abbreviation
Quantum Field Theory II		11-QFT2-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Quantum field theory II. Generating functionals. Path integral. Renormalisation. Renormalisation group. Gauge theories. Spontaneous symmetry breaking. Effective field theory (optional).		
Intended learning outcomes		
The students have advanced knowledge of the methods and concepts of quantum field theory. They have mastered the principles, especially of renormalisation and gauge theories. They are able to formulate and solve simple problems of quantum field theory by using the acquired calculation methods.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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### Module appears in

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)

Module title		Abbreviation
Quantum Information and Quantum Computing		11-QIC-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
The first part introduces the theoretical concepts of quantum information and quantum computers. It discusses the main quantum algorithms. The second part discusses experimental possibilities for the realisation of entangled states. One of the main topics is the production, controlling and manipulation of coherent two-electron spin states. The third part covers the description and explanation of decoherence of quantum mechanical states.		
Intended learning outcomes		
The students have an advanced understanding of quantum theory and basic knowledge of quantum calculation. They are able to solve simple problems of quantum information theory.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)

Module title		Abbreviation
Quantum Mechanics II		11-QM2-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
<p>"Quantum mechanics II" constitutes the central theoretical course of the international Master's program in Physics. It builds upon basics which are acquired in the lecture "Quantum mechanics I" of the Bachelor's degree. While the specific emphasis can be adjusted individually, the core topics that are supposed to be covered should include:</p> <ol style="list-style-type: none"> <li>1. Second quantisation: Fermions and bosons</li> <li>2. Band structures of particles in a crystal</li> <li>3. Angular momentum, symmetry operators, Lie Algebras</li> <li>4. Scattering theory: Potential scattering, partial wave expansion</li> <li>5. Relativistic quantum mechanics: Klein-Gordon equation, Dirac equation, Lorentz group, fine structure splitting of atomic spectra</li> <li>6. Quantum entanglement</li> <li>7. Canonical formalism</li> </ol>		
Intended learning outcomes		
The students acquire in-depth knowledge of advanced quantum mechanics and have a thorough understanding of the mathematical and theoretical concepts of the listed topics. They are able to describe or model problems of modern theoretical Quantum Physics mathematically, to solve problems analytically, to use approximation methods and to interpret the results physically. The course is pivotal to subsequent theory courses in Astrophysics, High-Energy Physics and Condensed Matter/Solid-State Physics. The course is mandatory for all Master's students.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)</p> <p>Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.</p> <p>Language of assessment: German, English</p>		
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<b>Allocation of places</b>
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<b>Additional information</b>
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
<p>Bachelor' degree (1 major) Physics (2010)          Bachelor' degree (1 major) Physics (2012)          Bachelor' degree (1 major) Nanostructure Technology (2012)          Bachelor' degree (1 major) Mathematical Physics (2009)          Bachelor' degree (1 major) Mathematical Physics (2012)          Master's degree (1 major) Mathematics (2012)          Master's degree (1 major) Mathematics (2010)          Master's degree (1 major) Physics (2010)          Master's degree (1 major) Physics (2011)          Master's degree (1 major) Nanostructure Technology (2011)          Master's degree (1 major) Nanostructure Technology (2010)          Master's degree (1 major) Mathematical Physics (2012)          Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)          Master's degree (1 major) FOKUS Physics (2010)          Master's degree (1 major) FOKUS Physics (2011)          Master's degree (1 major) Computational Mathematics (2012)</p>

Module title		Abbreviation
Many Body Quantum Theory		11-QVTP-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
<p>This will usually be a course on quantum many particle physics approached by the perturbative methods using Green's functions.</p> <p>An outline could be:</p> <ol style="list-style-type: none"> <li>1 Single-particle Green's function</li> <li>2 Review of second quantization</li> <li>3 Diagrammatic method using many particle Green's functions at temperature <math>T=0</math></li> <li>4 Diagrammatic method for finite <math>T</math></li> <li>5 Landau theory of Fermi liquids</li> <li>6 Superconductivity</li> <li>7 One-dimensional systems and bosonization</li> </ol>		
Intended learning outcomes		
The students have mastered the principles of quantum field theory in many-particle systems. They are able to apply the acquired methods to current problems of Theoretical Solid-State Physics.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)</p> <p>Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.</p> <p>Language of assessment: German, English</p>		
Allocation of places		
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Additional information		
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Mathematical Physics (2012) Master's degree (1 major) Mathematics (2010) Master's degree (1 major) Physics (2010) Master's degree (1 major) Physics (2011) Master's degree (1 major) Nanostructure Technology (2011) Master's degree (1 major) Nanostructure Technology (2010) Master's degree (1 major) Mathematical Physics (2012) Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010) Master's degree (1 major) FOKUS Physics (2010) Master's degree (1 major) FOKUS Physics (2011)



Module title		Abbreviation
Relativistic Effects in Mesoscopic Systems		11-RMS-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Relativistic effects in mesoscopic systems. - Spin-orbit coupling. - Dirac equation. - Quantum Hall effect. - Topological insulators. - Majorana fermions		
Intended learning outcomes		
The students have mastered the mathematical methods for the description of relativistic quantum systems, especially in the field of mesoscopic physics. They are able to apply their knowledge to simple systems.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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Module appears in		
Bachelor's with 1 major Mathematical Physics (2009)		
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Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)

Module title		Abbreviation
Renormalization Theory		11-RNT-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Renormalisation group methods for Hamiltonian systems. Partial non-linear differential equations with scaling behaviour for dynamics beyond the equilibrium. Classical-critical and quantum-critical phenomena and their relevance for phase diagrams in cryogenic temperatures. Instability of statistical and dynamic mean-field solutions. Stochastic non-linear partial differential equations. Construction of generating functionals. Halperin-Hohenberg-Ma differential equations. Symmetries, e.g. in the stochastic Burgers' equation (KPZ equation). Introduction and comparison of different RG methods.		
Intended learning outcomes		
The students have gained an overview of renormalisation group methods for non-linear partial differential equations. They know important examples and corresponding solving methods and are able to apply them to specific tasks.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
<p>Bachelor' degree (1 major) Physics (2010)</p> <p>Bachelor' degree (1 major) Physics (2012)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2009)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2012)</p> <p>Master's degree (1 major) Mathematics (2012)</p> <p>Master's degree (1 major) Mathematics (2010)</p> <p>Master's degree (1 major) Physics (2010)</p> <p>Master's degree (1 major) Physics (2011)</p> <p>Master's degree (1 major) Mathematical Physics (2012)</p> <p>Master's degree (1 major) FOKUS Physics (2010)</p> <p>Master's degree (1 major) FOKUS Physics (2011)</p> <p>Master's degree (1 major) Computational Mathematics (2012)</p>

Module title		Abbreviation
Relativistical Quantumfield Theory		11-RQFT-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Symmetries. Lagrange formalism for fields. Field quantisation. Gauge principle and interaction. Perturbation theory. Feynman rules. Quantum electrodynamic processes in Born approximation. Radiative corrections and renormalisation.		
Intended learning outcomes		
The students have mastered the principles and underlying mathematics of relativistic quantum field theories. They know how to use perturbation theory and how to apply Feynman rules. They are able to calculate basics processes in the framework of quantum electrodynamics in leading order. Moreover, they have a basic understanding of radiative corrections and renormalisation.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Theory of Relativity		11-RTT-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Mathematical foundations of the theory of relativity; differential forms; brief summary of special relativity; elements of differential geometry; electrodynamics as an example of a relativistic gauge theory; field equations of general relativity; stellar models; introduction to cosmology; Hamiltonian formulation		
Intended learning outcomes		
The students are familiar with the basic physical and mathematical concepts of general relativity. They have a mathematical understanding of the formulation of general relativity on the basis of differential forms. They are able to apply the acquired knowledge to problems of Astrophysics and cosmology.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)



Module title		Abbreviation
Statistics, Data Analysis and Computer Physics		11-SDC-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Statistics, data analysis and computer physics.		
Intended learning outcomes		
The students have specific and advanced knowledge in the field of statistics, data analysis and Computational Physics.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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Module appears in		
Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2012)		
Bachelor's with 1 major Mathematical Physics (2009)	JMU Würzburg • generated 26-Aug-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2009	page 113 / 133

Bachelor' degree (1 major) Nanostructure Technology (2010)  
 Bachelor' degree (1 major) Nanostructure Technology (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Seminar Mathematical Physics		11-SMP-092-m01
Module coordinator		Module offered by
chairperson of examination committee Mathematische Physik (Mathematical Physics)		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	undergraduate	Admission prerequisite to assessment: regular attendance and successful preparation of seminar presentation.
<b>Contents</b>		
A selected topic of Mathematical Physics.		
<b>Intended learning outcomes</b>		
The students learn about the principles of independent scientific work. This involves the development and division of a given topic on the basis of literature, the preparation of a lecture as well as the ability to actively participate in discussions.		
<b>Courses</b> (type, number of weekly contact hours, language — if other than German)		
S (no information on SWS (weekly contact hours) and course language available)		
<b>Method of assessment</b> (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
talk with discussion (approx. 60 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English if agreed upon with the examiner		
<b>Allocation of places</b>		
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<b>Additional information</b>		
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<b>Workload</b>		
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<b>Teaching cycle</b>		
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)		
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<b>Module appears in</b>		
Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Mathematical Physics (2012)		

Module title		Abbreviation
Statistical Mechanics, Thermodynamics and Electrodynamics		11-STE-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
16	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	10-M1-PHY and 10-M2-PHY or 10-M1-NST and 10-M2-NST
Contents		
Principles of Statistical Physics: Ideal systems. Thermodynamics: Quantum statistics, systems of interacting particles, critical phenomena, Maxwell equations, electrostatics, magnetostatics, Maxwell equations in matter, dynamics of electromagnetic fields. Special relativity.		
Intended learning outcomes		
The students have advanced knowledge of the methods of Theoretical Physics. They know the principles of electrodynamics, thermodynamics and statistical mechanics. They are familiar with the corresponding calculation methods and are able to independently apply them to the description and solution of problems in this area.		
Courses (type, number of weekly contact hours, language — if other than German)		
Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester) Theoretische Elektrodynamik (Theoretical Electrodynamics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>This module has the following assessment components</p> <ol style="list-style-type: none"> <li>Topics covered in lectures and exercises in part 1 (Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in part 2 (Theoretische Elektrodynamik (Theoretical Electrodynamics)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in parts 1 and 2: oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).</li> </ol> <p>Assessment component 3 will be offered in German; English if agreed upon with examiner(s).            Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2.            Students are highly recommended to attend both courses Statistische Mechanik und Thermodynamik (Statistical Mechanics and Thermodynamics) and Theoretische Elektrodynamik (Theoretical Electrodynamics). The topics discussed in these two courses will be covered in assessment component 3.            Students must register for assessment components 1 through 3 online (details to be announced).            To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 3.            The grade achieved in assessment component 1 or 2 (whichever is better) and the grade achieved in assessment component 3 will each count 50% towards the overall grade awarded for the module.</p>		
Allocation of places		
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Additional information		
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Workload		
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
<p>Bachelor' degree (1 major) Mathematics (2012)</p> <p>Bachelor' degree (1 major) Mathematics (2013)</p> <p>Bachelor' degree (1 major) Physics (2010)</p> <p>Bachelor' degree (1 major) Physics (2012)</p> <p>Bachelor' degree (1 major) Nanostructure Technology (2010)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2009)</p> <p>Bachelor' degree (1 major) Mathematical Physics (2012)</p> <p>Bachelor' degree (1 major) Computational Mathematics (2012)</p> <p>Bachelor' degree (1 major) Computational Mathematics (2013)</p> <p>Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)</p>

Module title		Abbreviation
Supersymmetry I and II		11-SUS-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
6	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Supersymmetry I: Grassmann variable. Coleman-Mandula theorem and Haag-Lopuszanski-Sohnius theorem. Supersymmetry: Algebra and multiplets. Superfield formalism. Breaking of supersymmetry. Supersymmetry II: Minimal supersymmetric standard model. Higgs sector. The spectrum of supersymmetric particles. Phenomenology of LEP, Tevatron and LHC, supersymmetric neutrino mass models. Violation of R-parity.		
Intended learning outcomes		
The students have knowledge of the mathematical and physical principles of supersymmetry and supersymmetric models. They understand the theory's formalism and recognise its connections to other models as well as its importance for phenomenology of elementary particles.		
Courses (type, number of weekly contact hours, language — if other than German)		
V + R (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)  
 Master's degree (1 major) FOKUS Physics (2006)

Module title		Abbreviation
Theoretical Elementary Particle Physics		11-TEP-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Fundamental forces and particles. Groups and symmetries. Quark model. Principles of quantum field theory. Gauge theories. Spontaneous symmetry breaking. Electroweak standard model. Quantum chromodynamics. Extensions of the standard model.		
Intended learning outcomes		
The students are familiar with the mathematical methods of Elementary Particle Physics. They understand the structure of the standard model based on symmetry principles and experimental observations. They know calculation methods for the processing of simple problems and processes of Elementary Particle Physics. Furthermore, they know the tests and limits of the standard model and the basics of extended theories.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Theoretical Solid State Physics		11-TFK-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Principles of Theoretical Solid-State Physics. Fermi liquid theory. Electron-electron interaction. Variational methods. Magnetism. Superconductivity.		
Intended learning outcomes		
The students have basic knowledge of the theoretical description of solid-state phenomena. They know the corresponding mathematical or theoretical methods and are able to apply them to basic problems of solid-state theory and to understand the connections to experimental results. The individual students have elaborated on an advanced topic of solid-state theory and have discussed this topic in a seminar presentation.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Experimental Particle Physics		11-TPE-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Applied Physics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
4	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Physics with modern particle detectors at the LHC and at the Tevatron. Discovery of the Higgs boson. Search for supersymmetry and other physics beyond the standard model. Determination of the top quark mass and W mass as well as other parameters of the standard model. Introduction to modern methods of analysis and assessment of systematic errors.		
Intended learning outcomes		
The students are familiar with the principles of modern particle detector physics, especially with currently open questions of Particle Physics, which are examined by using these detectors. They know modern methods of analysis and are able to put results into context and to assess their systematic uncertainties.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Particle Physics (Standard Model)		11-TPS-092-m01
Module coordinator		Module offered by
Managing Directors of the Institute of Applied Physics and the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
8	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Introduction to the theory of electroweak interaction and spontaneous symmetry breaking. Experiments on the standard model and determination of model parameters.		
Intended learning outcomes		
The students know the theoretical fundamental laws of the standard model of Particle Physics and the key experiments that have established and confirmed the standard model. They are able to interpret experimental or theoretical results in the framework of the standard model and know its validity and limits.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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Referred to in LPO I (examination regulations for teaching-degree programmes)		
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### Module appears in

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)

Module title		Abbreviation
Theoretical Mechanics and Quantum Mechanics		11-TQM-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
16	numerical grade	--
Duration	Module level	Other prerequisites
2 semester	undergraduate	10-M1-PHY, 10-M2-PHY and 11-MPI-3 or 10-M1-NST, 10-M2-NST and MPI-3
Contents		
Newtonian mechanics. Lagrangian and Hamiltonian formalism. Symmetries and conservation laws. Applications: Problems of central forces, minor vibrations, rigid body, motion in electromagnetic fields. Relativistic dynamics. Limits of classical physics. Schrödinger equation, mathematical principles of quantum mechanics, harmonic oscillator. Angular momentum and spin. Hydrogen atom. Methods of approximation. Motion in electric fields. Many-particle systems.		
Intended learning outcomes		
The students have gained first experiences concerning the working methods of Theoretical Physics. They are familiar with the principles of theoretical mechanics and their different formulations and understand the principles of quantum theory. They are able to apply the acquired calculation methods and techniques to simple problems of Theoretical Physics and to interpret the results. They have especially acquired knowledge of basic mathematical concepts.		
Courses (type, number of weekly contact hours, language — if other than German)		
Theoretische Mechanik (Theoretical Mechanics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester) Quantenmechanik (Quantum Mechanics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (summer semester)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>This module has the following assessment components</p> <ol style="list-style-type: none"> <li>Topics covered in lectures and exercises in part 1 (Theoretische Mechanik (Theoretical Mechanics)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in part 2 (Quantenmechanik (Quantum Mechanics)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in parts 1 and 2: oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).</li> </ol> <p>Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2.</p> <p>To qualify for admission to assessment component 3, students must pass assessment component 1 and/or 2. Students are highly recommended to attend both courses Theoretische Mechanik (Theoretical Mechanics) and Quantenmechanik (Quantum Mechanics). The topics discussed in these two courses will be covered in assessment component 3.</p> <p>Students must register for assessment components 1 through 3 online (details to be announced).</p> <p>To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 3.</p> <p>The grade achieved in assessment component 1 or 2 (whichever is better) and the grade achieved in assessment component 3 will each count 50% towards the overall grade awarded for the module.</p>		
Allocation of places		
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Additional information		
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<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
Bachelor' degree (1 major) Mathematics (2012) Bachelor' degree (1 major) Mathematics (2013) Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Mathematical Physics (2012) Bachelor' degree (1 major) Computational Mathematics (2012) Bachelor' degree (1 major) Computational Mathematics (2013) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2010)

Module title		Abbreviation
<b>Theoretical Mechanics and Quantum Mechanics for FOKUS Students</b>		11-TQM-F-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
16	numerical grade	10-M-PHY1 and 10-M-PHY2 or 10-M-NST1 and 10-M-NST2 and 11-TQM-1, 11-KP
Duration	Module level	Other prerequisites
2 semester	undergraduate	--
Contents		
Newtonian mechanics. Lagrangian and Hamiltonian formalism. Symmetries and conservation laws. Applications: Problems of central forces, minor vibrations, rigid body, motion in electromagnetic fields. Relativistic dynamics. Limits of classical physics. Schrödinger equation, mathematical principles of quantum mechanics, harmonic oscillator. Angular momentum and spin. Hydrogen atom. Methods of approximation. Motion in electric fields. Many-particle systems		
Intended learning outcomes		
The students have gained first experiences concerning the working methods of Theoretical Physics. They are familiar with the principles of theoretical mechanics and their different formulations and understand the principles of quantum theory. They are able to apply the acquired calculation methods and techniques to simple problems of Theoretical Physics and to interpret the results. They have especially acquired knowledge of basic mathematical concepts.		
Courses (type, number of weekly contact hours, language — if other than German)		
Theoretische Mechanik (Theoretical Mechanics): V (4 weekly contact hours) + Ü (2 weekly contact hours), once a year (winter semester) Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students): V (4 weekly contact hours) + Ü (2 weekly contact hours) + T (1 weekly contact hour), once a year (block taught during semester break between summer and winter semester)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
<p>This module has the following assessment components</p> <ol style="list-style-type: none"> <li>Topics covered in lectures and exercises in part 1 (Theoretische Mechanik (Theoretical Mechanics)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in part 2 (Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students)): written examination (approx. 120 minutes).</li> <li>Topics covered in lectures and exercises in parts 1 and 2: oral examination of one candidate each (approx. 30 minutes, usually chosen) or written examination (approx. 120 minutes).</li> </ol> <p>Successful completion of approx. 50% of practice work each is a prerequisite for admission to assessment components 1 and 2. To qualify for admission to assessment component 3, students must pass assessment component 1 and/or 2. Students are highly recommended to attend both courses Theoretische Mechanik (Theoretical Mechanics) and Quantenmechanik für FOKUS-Studierende (Quantum Mechanics for FOKUS Students). The topics discussed in these two courses will be covered in assessment component 3. Students must register for assessment components 1 through 3 online (details to be announced). To pass this module, students must first pass assessment component 1 or 2 and must then pass assessment component 3. The grade achieved in assessment component 1 or 2 (whichever is better) and the grade achieved in assessment component 3 will each count 50% towards the overall grade awarded for the module.</p>		
Allocation of places		
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<b>Additional information</b>
Students who intend to study the FOKUS Master's degree programme must take Quantenmechanik für FO-KUS-Studierende (Quantum Mechanics for FOKUS Students) instead of Quantenmechanik (Quantum Mechanics).
<b>Workload</b>
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<b>Teaching cycle</b>
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<b>Referred to in LPO I</b> (examination regulations for teaching-degree programmes)
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<b>Module appears in</b>
Bachelor' degree (1 major) Physics (2010) Bachelor' degree (1 major) Physics (2012) Bachelor' degree (1 major) Nanostructure Technology (2010) Bachelor' degree (1 major) Mathematical Physics (2009) Bachelor' degree (1 major) Mathematical Physics (2012)

Module title		Abbreviation
Theory of Superconduction		11-TSL-092-m01
Module coordinator		Module offered by
Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics and Astronomy
ECTS	Method of grading	Only after succ. compl. of module(s)
5	numerical grade	--
Duration	Module level	Other prerequisites
1 semester	graduate	Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.
Contents		
Introduction to the phenomenon of superconductivity. Microscopic theory of superconductivity (BCS theory). Phenomenological theory of superconductivity (Ginzburg-Landau theory). Mesoscopic aspects of superconductivity (Andreev scattering, Boboliubov-de Gennes equation, SQUIDS). Quantum computing with superconductive elements.		
Intended learning outcomes		
The students have basic knowledge of the theoretical models for the description of superconductivity. They know the properties and application areas of these models and are able to apply calculation methods to simple problems.		
Courses (type, number of weekly contact hours, language — if other than German)		
R + V (no information on SWS (weekly contact hours) and course language available)		
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus)		
a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate, for modules with less than 4 ECTS credits approx. 20 minutes) or c) project report (approx. 8 to 10 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes) Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009. Language of assessment: German, English		
Allocation of places		
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Additional information		
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Workload		
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Teaching cycle		
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module appears in**

Bachelor' degree (1 major) Physics (2010)  
 Bachelor' degree (1 major) Physics (2012)  
 Bachelor' degree (1 major) Mathematical Physics (2009)  
 Bachelor' degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) Mathematics (2012)  
 Master's degree (1 major) Mathematics (2010)  
 Master's degree (1 major) Physics (2010)  
 Master's degree (1 major) Physics (2011)  
 Master's degree (1 major) Nanostructure Technology (2011)  
 Master's degree (1 major) Nanostructure Technology (2010)  
 Master's degree (1 major) Mathematical Physics (2012)  
 Master's degree (1 major) FOKUS Physics - Nanostructuring Technology (2010)  
 Master's degree (1 major) FOKUS Physics (2010)  
 Master's degree (1 major) FOKUS Physics (2011)  
 Master's degree (1 major) Computational Mathematics (2012)