

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: 2024 Responsible: Faculty of Mathematics and Computer Science Responsible: Institute of Mathematics Responsible: Faculty of Physics and Astronomy

JMU Würzburg • generated 30-Mär-2024 • exam. reg. data record 82|b55|-|-|H|2024

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Learning Outcomes

German contents and learning outcome available but not translated yet.

Wissenschaftliche Befähigung

- Die Absolventinnen und Absolventen sind vertraut mit den Arbeitsweisen und der zugehörigen Fachsprache der Mathematik und beherrschen die Methoden mathematischen Denkens und Beweisens.
- Die Absolventinnen und Absolventen besitzen Kenntnisse mathematischer Grundlagen der Theoretischen Physik und sind vertraut mit den grundlegenden Beweismethoden dieser Gebiete.
- Die Absolventinnen und Absolventen verstehen die mathematischen, theoretischen und experimentellen Grundlagen der Physik und können diese anwenden.
- Die Absolventinnen und Absolventen können unter Anleitung Experimente durchführen, analysieren und die erhaltenen Ergebnisse darstellen und bewerten.
- Die Absolventinnen und Absolventen sind in der Lage, physikalische Probleme durch Anwendung der wissenschaftlichen Arbeitsweise und unter Beachtung der Regeln guter wissenschaftlicher Praxis (Dokumentation, Fehleranalyse) zu bearbeiten.
- Die Absolventinnen und Absolventen verstehen die wesentlichen Zusammenhänge und Konzepte der einzelnen Teilgebiete der Theoretischen Physik.
- Die Absolventinnen und Absolventen sind in der Lage, ihre mathematischen Fähigkeiten auf physikalische Fragestellungen anzuwenden.
- Die Absolventinnen und Absolventen sind geschult in analytischem Denken, besitzen ein hohes Abstraktionsvermögen, universell einsetzbare Problemlösungskompetenz und die Fähigkeit, komplexe Zusammenhänge zu strukturieren.
- Die Absolventinnen und Absolventen sind in der Lage, sich selbständig mithilfe von Fachliteratur in weitere Gebiete der Mathematik und Physik einzuarbeiten.
- Die Absolventinnen und Absolventen sind in der Lage, ihre Kenntnisse, Ideen und Problemlösungen verständlich zu präsentieren.
- Die Absolventinnen und Absolventen besitzen die für ein weiterführendes, insbesondere Master-Studium in Mathematik und Physik, erforderlichen Grundkenntnisse, Denk- und Arbeitsweisen und Methodenkenntnisse.
- Die Absolventinnen und Absolventen kennen die Regeln guter wissenschaftlicher Praxis und sind in der Lage, sie in ihrer eigenen Arbeit zu beachten.

Befähigung zur Aufnahme einer Erwerbstätigkeit

- Die Absolventinnen und Absolventen sind geschult in analytischem Denken, besitzen ein hohes Abstraktionsvermögen, universell einsetzbare Problemlösungskompetenz und die Fähigkeit, komplexe Zusammenhänge zu strukturieren.
- Die Absolventinnen und Absolventen sind in der Lage, ihre Kenntnisse, Ideen und Problemlösungen zielgruppenorientiert verständlich, auch in einer Fremdsprache zu formulieren und zu präsentieren.
- Die Absolventinnen und Absolventen sind in der Lage, konkrete Probleme zu erkennen, strukturieren und modellieren und mit mathematischen und physikalischen Methoden Lösungswege zu entwickeln.
- Die Absolventinnen und Absolventen besitzen ein ausgeprägtes Durchhaltevermögen bei der Lösung komplexer Probleme.
- Die Absolventinnen und Absolventen sind in der Lage, sich weitere Wissensgebiete selbständig, effizient und systematisch zu erschließen.
- Die Absolventinnen und Absolventen sind in der Lage, konstruktiv und zielorientiert in einem heterogenen, interdisziplinären Team zusammenzuarbeiten, unterschiedliche und abweichen-

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de Ansichten produktiv zur Zielerreichung zu nutzen und auftretende Konflikte zu lösen (Teamfähigkeit).

• Die Absolventinnen und Absolventen sind in der Lage, Daten mit Hilfe von statistischen Methoden zu analysieren, zu interpretieren und darzustellen.

Persönlichkeitsentwicklung

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- Die Absolventinnen und Absolventen sind geschult in analytischem Denken, besitzen ein hohes Abstraktionsvermögen, universell einsetzbare Problemlösungskompetenz und die Fähigkeit, komplexe Zusammenhänge zu strukturieren.
- Die Absolventinnen und Absolventen kennen die Regeln guter wissenschaftlicher Praxis und sind in der Lage, sie in ihrer eigenen Arbeit zu beachten.
- Die Absolventinnen und Absolventen sind in der Lage, gesellschaftliche, wirtschaftliche und historische Entwicklungen und Prozesse kritisch zu reflektieren und zu bewerten.
- Die Absolventinnen und Absolventen entwickeln die Bereitschaft und Fähigkeit, ihre Kompetenzen in partizipative Prozesse einzubringen und aktiv an Entscheidungen mitzuwirken.
- Die Absolventinnen und Absolventen besitzen ein ausgeprägtes Durchhaltevermögen bei der Lösung komplexer Probleme.
- Die Absolventinnen und Absolventen sind in der Lage, Ideen und Lösungsvorschläge allgemeinverständlich zu formulieren und präsentieren.

Abbreviations used

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

ASPO2015

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

06-Sep-2023 (2023-72)

??-???-2024 (2024-??)

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.

Bachelor's with 1 major Mathematical Physics	
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Compulsory Courses

(104 ECTS credits)



Subfield Analysis

(25 ECTS credits)

Module	e title				Abbreviation
Overview Analysis for Mathematical Physics 10-M-ANP-Ü-202-m01					10-M-ANP-Ü-202-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics
ECTS Method of grading Only after suc			Only after succ. con	npl. of module(s)	
16	nume	rical grade			
Duration Module level Other prerequisites					
2 seme	ster	undergraduate			
Conten	ts				
tegral c Further	alculu: topolo aylor's	s in one variable (Rieman gical considerations, nor theorem for multivariate	n integral and impro med and metric space	per integral). ces; basics in differe	culus in one variable; basics of in- ential calculus in several varia- ; inverse function theorem, impli-
Intende	ed lear	ning outcomes			
them in lytic ba ten and Course	ndepen Ickgrou I oral fo S (type, r	dently, He/She has an ov nd and geometric interpr orm. number of weekly contact hours, l	verview over the fund etation, and can inte	amental notions an rconnect them and o	f analysis and is able to apply d concepts of analysis, their ana- express them adequately in writ-
V (4) +	V (4) +	Ü (2)			
		sessment (type, scope, langua Ile for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
Assess	ment w	ion of one candidate each vill have reference to the ssessment: German and,	contents of modules	10-M-ANAP1 and 10	-M-ANAP2.
Allocat	ion of _l	olaces			
Additio	nal inf	ormation			
Worklo	ad				
480 h					
Teachi	ng cycl	e			
Referre	d to in	LPOI (examination regulation	s for teaching-degree progra	ummes)	
Module	e appea	ars in			
	-	ree (1 major) Mathematic ree (1 major) Mathematic	, , ,		

Bachelor's with 1 major Mathematical Physics (2024)

Module title Abbreviation					Abbreviation
Advan	ced Ana	alysis			10-M-VAN-202-m01
Modul	e coord	inator		Module offered by	I
Dean c	of Studi	es Mathematik (Mathen	natics)	Institute of Mathen	natics
ECTS Method of grading Only after succ.		Only after succ. con	npl. of module(s)		
9	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ester	undergraduate			
Conter	nts				
Contin rems.	uation	of analysis in several va	riables; Lebesgue mea	asure and Lebesgue	integral in R^n, integral theo-
Intend	ed lear	ning outcomes			
		acquainted with advan understand the constru			e of the Lesbegue integral, he or
Course	es (type, r	number of weekly contact hours	, language — if other than Ge	rman)	
V (4) +	Ü (2)				
		sessment (type, scope, langu ole for bonus)	uage — if other than German,	examination offered — if no	ot every semester, information on whether
b) oral c) oral credita	examir examin Ible for	mination (approx. 90 to nation of one candidate nation in groups (groups bonus ussessment: German and	each (15 to 30 minute of 2, 10 to 15 minutes	s) or	
	tion of				
Additio	onal inf	ormation			
Worklo	bad				
270 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree progra	ummes)	
Modul	e appea	ars in			
Bachel	lor' deg	ree (1 major) Mathemat	ical Physics (2020)		
	-	ree (1 major) Mathemat			



Subfield Linear Algebra

(16 ECTS credits)

Module title At				Abbreviation		
Overview Linear Algebra for Mathematical Physics 10-M-LNP			10-M-LNP-Ü-202-m01			
Module coordinator				Module offered by		
Dean of Studies Mathematik (Mathematics) Institute of Mathematics			natics			
ECTS Method of grading Only after succ. compl. of module(s)						
16	numerical grade					
Duratio	n	Module level	Other prerequisites			
2 seme	ster	undergraduate				
Conten	ts					
vector s direct s tation, al, inva product	spaces ums ar determ riant su t, ortho	over arbitrary fields: line nd quotients of subspace inants. Eigenvalue theon ubspaces, diagonalisabil	ar independance, ba s, linear maps, kerne y: characteristic polyr ity, nilpotent maps, J	sis, dimension, coor el and image, dimens nomial, Caley-Hamilt ordan normal form; l	algorithm, echolon form, rank; rdinates, change of basis, sums, sion theorem, matrix represen- ton theorem, minimal polynomi- Euclidean/unitary spaces: scalar es, selfadjoint and normal matri-	
Intende	ed learr	ning outcomes				
The student knows and masters the essential methods and proof techniques of linear algebra and is able to apply them independently. He/She has an overview over the fundamental notions and methods of linear algebra, knows about their algebraic and geometric background, is able to relate them to each other and can present them adequately in written and oral form.						
Courses (type, number of weekly contact hours, language — if other than German)						
V (4) + V (4) + Ü (2)						
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)						
oral examination of one candidate each (20 to 40 minutes) Assessment will have reference to the contents of modules 10-M-LNAP1 and 10-M-LNP-Ü. Language of assessment: German and/or English						
Allocat	Allocation of places					
Additio	nal info	ormation				
Worklo	ad					
480 h						
Teachir	ng cycl	e				
Referre	d to in	LPOI (examination regulations	s for teaching-degree progra	mmes)		
Module	e appea	irs in				
	Bachelor' degree (1 major) Mathematical Physics (2020)					
Bachel	Bachelor' degree (1 major) Mathematical Physics (2024)					



Subfield Classical Physics

(16 ECTS credits)

Module coordination Managing Direct ECTS Method 8 numeric Duration N 1 semester u Contents 1. Principles: Phr 1. Principles: Phr finition, measure 2. Point Mechan motion, free fall	tor of the Institute of Ap of grading cal grade Module level indergraduate ysical quantities, preface rement procedures, SI),	Only after succ. com Other prerequisites Admission prerequisites 13 exercise sheets p approx. 50% of exer lecturer will inform so of the semester.	site to assessment: o er semester). Stude cises will qualify for	11-E-M-152-mo1 and Astronomy completion of exercises (approx. nts who successfully completed admission to assessment. The espective details at the beginning
Managing Direct ECTS Method 8 numeric Duration N 1 semester u Contents 1. Principles: Phr finition, measure 2. Point Mechan motion, free fall,	tor of the Institute of Ap of grading cal grade Module level indergraduate ysical quantities, preface rement procedures, SI),	Only after succ. com Other prerequisites Admission prerequisites 13 exercise sheets p approx. 50% of exer lecturer will inform so of the semester.	Faculty of Physics a pl. of module(s) site to assessment: of er semester). Stude cises will qualify for	completion of exercises (approx. nts who successfully completed admission to assessment. The
ECTS Method 8 numeric Duration N 1 semester u Contents 1. Principles: Phy finition, measure 2. Point Mechan motion, free fall,	of grading cal grade Aodule level indergraduate ysical quantities, preface rement procedures, SI),	Only after succ. com Other prerequisites Admission prerequisites 13 exercise sheets p approx. 50% of exer lecturer will inform so of the semester.	site to assessment: er semester). Stude cises will qualify for	completion of exercises (approx. nts who successfully completed admission to assessment. The
8 numeric Duration N 1 semester u Contents 1. Principles: Phr finition, measure 2. Point Mechan motion, free fall,	al grade Aodule level Indergraduate ysical quantities, preface rement procedures, SI),	 Other prerequisites Admission prerequisites 13 exercise sheets p approx. 50% of exer lecturer will inform s of the semester.	site to assessment: o er semester). Stude cises will qualify for	nts who successfully completed admission to assessment. The
8 numeric Duration N 1 semester u Contents 1. Principles: Phr finition, measure 2. Point Mechan motion, free fall,	al grade Aodule level Indergraduate ysical quantities, preface rement procedures, SI),	 Other prerequisites Admission prerequisites 13 exercise sheets p approx. 50% of exer lecturer will inform s of the semester.	site to assessment: o er semester). Stude cises will qualify for	nts who successfully completed admission to assessment. The
Duration N 1 semester u 1 semester u Contents u 1. Principles: Phrinition, measure u 2. Point Mechan motion, free fall,	Aodule level Indergraduate ysical quantities, preface rement procedures, SI),	Admission prerequis 13 exercise sheets p approx. 50% of exer lecturer will inform s of the semester.	site to assessment: er semester). Stude cises will qualify for	nts who successfully completed admission to assessment. The
1 semester u Contents 1. Principles: Phy finition, measure 2. Point Mechan motion, free fall,	ysical quantities, prefa	Admission prerequis 13 exercise sheets p approx. 50% of exer lecturer will inform s of the semester.	site to assessment: er semester). Stude cises will qualify for	nts who successfully completed admission to assessment. The
1. Principles: Ph finition, measur 2. Point Mechan motion, free fall	ement procedures, SI),	ctors, derived quanti		
finition, measure 2. Point Mechan motion, free fall	ement procedures, SI),	ctors, derived quanti		
mic scale, isotro 4. Work and ene 5. Elastic, inelas and balance sys 6. Conservative and potential of 7. Rotational mo gies to linear tra in the central po 8. Tidal forces: I gal force; 9. Galilean trans postulates, prob pulse; 10. Rigid body a their stability, te tation, the Earth 11. Friction: Stati mation; 12. Vibration: Re power approach vibration (resona 13. Coupled vibr non-linear dynau 14. Waves: Wave at the open and relation; 15. Elastic deform 16. Fluids: Hydro	, slate litter; circular mo s: Forces and momentu opic and anisotropic fric ergy: (Kinetic) performan stic and super-elastic co stem, rocket equation; and non-conservative fr gravity (general relation otion: Angular momentu anslation, applications, otential; nertial system, reference sformation: Brief digress olem of simultaneity, Lo and gyroscope: Determinensor on the example of a sa a spinning top; ic and dynamic friction, ant case, Kriechfall, appr rations: Eigenvalues and mics and chaos; e equation, transverse a closed end, speed of si mation of solid bodies: ostatic pressure and bu	n in 2D and 3D / vector of in polar coordin im definition, weight ction. Preparation of the nee, examples; ollision: Energy and n force fields: Potential ns); um, angular velocity, satellites (geostation ce systems, apparent sion to Maxwell's equipmentz transformation ning the centre of ma f the elasticity tensor , stick-slip motion, ro s of complex e-function eriodic limit), forced d eigenfunctions, do and longitudinal wav ound; interference, D Elastic modulus, ger oyancy, surface tens	ors, special cases: Unates; vs. mass forces on t the equations of more nomentum conserva , potential energy; la torque, rotational er nary and interstellar) forces, Foucault per uations, ether, Mich , time dilation and lo ss, inertia tensor an , physics of the bike offing friction, viscou on, equation of moti n; spring and pendul vibration, Fourier an uble pendulum, dete es, polarisation, prir oppler effect; phase heral Hooke's law, ef-	tion, surges in centre of mass aw, weight scale, field strength hergy, moment of inertia, analo-), escape velocities, trajectories ndulum, Coriolis force, centrifu- elson interferometer, Einstein's ength contraction, relativistic im- d -ellipsoid, principal axes and r; gyroscope: Precession and nu- s friction, laminar flow, eddy for- on (DGL) on forces, torque and lum, physical pendulum, damped alysis; erministic vs. chaotic motion, nciple of superposition, reflection e and group velocity, dispersion

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Intended learning outcomes

The students understand the basic contexts and principles of mechanics, vibration, waves and kinetic theory of gases. 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.

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

V (4) + Ü (2)

Module taught in: Ü: German or English

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

written examination (approx. 120 minutes)

Language of assessment: German and/or English

Allocation of places

Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload

240 h

Teaching cycle

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

§ 53 | Nr. 1 a) § 77 | Nr. 1 a)

Module appears in

Module appears in						
Bachelor' degree (1 major) Physics (2	2015)					
Bachelor' degree (1 major) Nanostructure Technology (2015)						
Bachelor' degree (1 major) Mathematical Physics (2015)						
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)						
First state examination for the teach	ing degree Grundschule Physics (2015)					
First state examination for the teach	ing degree Realschule Physics (2015)					
First state examination for the teach	ing degree Gymnasium Physics (2015)					
First state examination for the teach	ing degree Mittelschule Physics (2015)					
Bachelor' degree (1 major) Mathema	tical Physics (2016)					
First state examination for the teach	ing degree Grundschule Physics (2018)					
First state examination for the teach	ing degree Realschule Physics (2018)					
First state examination for the teach	ing degree Gymnasium Physics (2018)					
First state examination for the teach	ing degree Mittelschule Physics (2018)					
Bachelor' degree (1 major) Physics (2	2020)					
Bachelor' degree (1 major) Nanostru	cture Technology (2020)					
Bachelor' degree (1 major) Mathema	tical Physics (2020)					
Bachelor's degree (1 major, 1 minor)	Physics (Minor, 2020)					
First state examination for the teach	ing degree Grundschule Physics (2020)					
First state examination for the teach	ing degree Gymnasium Physics (2020)					
First state examination for the teach	ing degree Realschule Physics (2020)					
Bachelor's with 1 major Mathematical Physics	JMU Würzburg • generated 30-Mär-2024 • exam. reg. da-	page 17 / 160				
(2024)	ta record Bachelor (180 ECTS) Mathematische Physik - 2024					

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

First state examination for the teaching degree Mittelschule Physics (2020) Bachelor' degree (1 major) Functional Materials (2021) Bachelor' degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module	e title				Abbreviation	
Classic	al Phys	sics 2 (Heat and Electro	magnetism)		11-E-E-152-m01	
Module	e coord	inator		Module offered by		
Manag	Nanaging Director of the Institute of Applied Physics		Applied Physics	Faculty of Physics a	and Astronomy	
ECTS		od of grading	of grading Only after succ. compl. of module(s)			
8	<u> </u>	rical grade				
	·		Other prerequisites			
Duratio		Module level	Other prerequisites			
1 seme	ster	undergraduate	13 exercise sheets p approx. 50% of exer	oer semester). Stude rcises will qualify for	completion of exerci nts who successfully admission to assess espective details at t	completed sment. The
Conten	ts					
3. Func 4. Heat 5. Real phenor 6. Elect point c 7. Gaus cial syr 8. Elect equipo lace eff 9. Matt on, the 10. Cap dia in t ectric c 11. Elect 12. Res ohmic, 13. Circ suring 14. Pov 15. Tran 16. May gnetic 17. Vec Helmho 18. Mor pole fie 19. mat ferrom 20. ind inducta 21. May equatio 22. AC: stance	lamenta engine gases a mena (c trostati harge; ssian se nmetrie trical po- tential fects, S ter in th rmionic bacitor, he capa lisplace tricity, istance NTC, P suits, el instrum ver and nsfer m gnetost field; A tor pote bltz coil ving ch eld; mo tter in t agnetis uction, ance,se xwell's pri funda ; Capac	ectrical networks, Kirch eents; Wheatstone brid energy in the circuit; C echanisms, conductior atics, fundamental law mper's Law, analogous ential, formal derivation s; arge in the static magn vement paths, mass sp he magnetic field, effec m; magn. moment of th Faraday's law of induc lf-induction; applicatio displacement current, ovell equations; mentals, sinusoidal vib itive & inductive resisted	ynamics, entropy, irrey fficiency, example: Sti hatter (also solids), var nee region, Joule-Thom ctrical charge, forces; e lomb's law, definition in n differential form; E-box, electric. potent rtant examples: Sphere omogeneous field, Mill omogeneous and inhor on, capacity; plate and sation, displacement a facitor; Piezoelectric effi- ensity, drift velocity, co stivity, temperature de shoff's rules (meshes, f ge; apacitor charge; galva in solids: Band mode s; permanent magnet, to e-box, magn. river, n, analogous to electric etic field, current balar ectrometer, Wien filter tis of the field on matter to Lenz's rule, flux c ns: Transformer, gener choice of integration approximation prations, amplitude, per protions, amplitude, per protions, amplitude, per per capacitor and coil, p	versibility, Maxwell's rling engine; a der Waals, critical p son; electric field, reps. fie of "river"; Gaussian s ial, potential differer e, hollow sphere, cap ikan experiment, Bra nogeneous field; inc spherical capacitor; nd orientation polari ect; onduction mechanism pendence; Ohm's la nodes); internal resis nic element; thermoo l, semiconductor; lin field properties, def swirl; c scalar potential; ca nce, Lorentz force, rig rs, Hall effect; electro er, relative permeabi at interfaces; hange, eddy electric rator; rea, displacement cu	point, phase transition eld concept, field line surface, divergence to nce, voltage; potentia pacitor plates, electron duction, Faraday cage combination of capa isation, microscopic ms; w; realisations (resist stance of a voltage so voltage; he in liquids and gase initions and units; En- cliculation of fields, ex- ght-hand rule, electri pon: e / m determination lity, susceptibility; pon- field, Waltenhofen's urrent; Maxwell's exter-	es, field of a cheorem; spe al equation, ic dipole; ield emissi- e; acitors; me- image; diel- stive and non ource, mea- es; arth's ma- xamples, ic motor; di- ion; ara-, dia-, s pendulum; ension, wave
COMPLE	ex resis	tance; performance of	line AC;			
		or Mathematical Physics	· · ·	generated 30-Mär-2024 • ex		page 19 / 160

23. Resonant circuits, combinations of RLC; series and parallel resonant circuit; forced vibration, damped harmonic oscillator (related to 11-E-M);

24: Hertz dipole, characteristics of irradiation, near field, far field; Rayleigh scattering; accelerated charge, synchrotron radiation, X-rays; 25. Electromagnetic waves: Principles, Maxwell's determination to electromagnetism, radiation pressure (Poynting vector, radiation pressure).

Intended learning outcomes

The students understand the basic principles and contexts of thermodynamics, science of electricity and magnetism. They know relevant experiments to observe and measure these principles and contexts. 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)

V (4) + Ü (2)

Module taught in: Ü: German or English

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

written examination (approx. 120 minutes) Language of assessment: German and/or English

Allocation of places

Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment to whose not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload

240 h

Teaching cycle

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

§ 53 | Nr. 1 a)

§ 77 | Nr. 1 a)

Module appears in

Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Nanostructure Technology (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) First state examination for the teaching degree Grundschule Physics (2015) First state examination for the teaching degree Realschule Physics (2015) First state examination for the teaching degree Gymnasium Physics (2015) First state examination for the teaching degree Mittelschule Physics (2015) First state examination for the teaching degree Mittelschule Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) First state examination for the teaching degree Grundschule Physics (2018) First state examination for the teaching degree Realschule Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018)

Bachelor's with 1 major Mathematical Physics	JMU Würzburg ● generated 30-Mär-2024 ● exam. reg. da-	page 20 / 160
(2024)	ta record Bachelor (180 ECTS) Mathematische Physik - 2024	

Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) First state examination for the teaching degree Grundschule Physics (2020) First state examination for the teaching degree Gymnasium Physics (2020) First state examination for the teaching degree Realschule Physics (2020) First state examination for the teaching degree Mittelschule Physics (2020) First state examination for the teaching degree Mittelschule Physics (2020) Bachelor' degree (1 major) Functional Materials (2021) Bachelor' degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)



Subfield Theoretical Mechanics and Quantum Mechanics

(16 ECTS credits)

These	title				Abbreviation	
ineoret	ical Me	chanics			11-T-M-152-m01	
Module	coordi	nator		Module offered by		
Managi	Managing Director of the Institute of Theoretical Pl and Astrophysics		Theoretical Physics	Faculty of Physics and Astronomy		
		thod of grading Only after succ. compl. of module(s)				
8	numeri	merical grade				
Duratio			Other prerequisites	;		
1 semes	ster	undergraduate	13 exercise sheets p approx. 50% of exer	per semester). Stude rcises will qualify for	completion of exerci nts who successfully admission to asses espective details at t	completed sment. The
Content	ts					
systems 3. Hamil Poisson Liouville 4. Appli electron ring, cro 5. Relati	s and a ltonian bracke theore cations magneti oss sect ivistic d	oparent forces; formulation: Legendre ets, canonical transforr em; Hamilton-Jacobi fo e: Central-force probler ic field; rigid bodies, to tion [optional]; lynamics: Lorentz Tran	en; symmetries, Noether e transformation, phase nations; generator of s rmulation [optional]; ns; mechanical similar orque and inertia tenso sformation; Minkowsk ptional]; deterministic	e space; Hamilton fu symmetries, conserv rity, Virial theorem; r or, centrifugal and Eu i space; equations c	inction, canonical ec ation laws; minimal ninor vibrations; par iler equations [optio	juations; coupling; ticles in an nal]; scatte-
		ing outcomes				
miliar w dently a	vith the apply th	principles of theoretic e acquired mathemati	ences concerning the v al mechanics and their cal methods and techr pecially acquired know	r different formulation niques to simple pro	ons. They are able to blems of Theoretical	indepen-
-		,	s, language — if other than Ge			
V (4) + Ü	Ü (2)	in: Ü: German or Engli				
Method	l of ass		uage — if other than German,	examination offered — if no	ot every semester, informat	ion on whether
		ation (approx. 120 mir sessment: German an				
	0		d/or English			
	-		d/or English			
Languag	-		a/or English			
Languag Allocati Addition	ion of p nal info	laces rmation	d/or English			

Workload

240 h

Teaching cycle

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

Module appears in

Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Nanostructure Technology (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor' degree (1 major, 2020) Bachelor' degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

1 semester undergraduate Admission prerequisite to assessment: completion of exercises (approx 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginnin of the semester. Contents . 1. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (QM); 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution fop pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; stat tionary solutions of SG 3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symme try properties; 6. Spin-1/2 systems [: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution of the eigenvalue equation in polar coordinates (concrete); 8. Central potential - hydrogen atom: Bonding states in 3D; Coulomb potential; 9. Motion in an electromagnetic field; Hamiltonian, Normal Zeeman effect; canonical and kinetic momentum; Gauge transformation, Aharonov-Bohm effect; Schrödinger, Heisenberg and interaction representation; motion of a free electron in a magnetic field; 10. Spin-1/2 systems II: Formulation using angular	Module	e title				Abbreviation	
Managing Director of the institute of Theoretical 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 Admission prerequisite to assessment: completion of exercises (semest presenseter). Students who successfully completed approx. so% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginnin of the semester. 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution fo pulse measurement; correspondence principles: postulates of QM. Ehrenfest theorem; continuity equation; sta tionary solutions of SG 3. Formalisation of QM: Eigenvalue equations: Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symmetry properies; 6. Spin-1/2 systems I: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution in an electromagnetic field: Hamiltonian; No	Quantu	ım Mec	hanics			11-T-Q-152-m01	
Managing Director of the institute of Theoretical 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 Admission prerequisite to assessment: completion of exercises (semest presenseter). Students who successfully completed approx. so% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginnin of the semester. 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution fo pulse measurement; correspondence principles: postulates of QM. Ehrenfest theorem; continuity equation; sta tionary solutions of SG 3. Formalisation of QM: Eigenvalue equations: Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symmetry properies; 6. Spin-1/2 systems I: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution in an electromagnetic field: Hamiltonian; No	Module	e coord	inator		Module offered by	<u> </u>	
and Astrophysics ECTS Method of grading Only after succ. compl. of module(s) 8 numerical grade 1 semester Undergraduate Admission prerequisite to assessment: completion of exercises (approx. 50% of exercises will quality for admission to assessment. The lecturer will inform students about the respective details at the beginnin of the semester. Contents				Theoretical Physics			
8 numerical grade Duration Module level Other prerequisite 1 semester undergraduate Admission prerequisite to assessment: completion of exercises (approx 19 exercises sheets per semester). Students who successfully completed approx, 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginnin of the semester. Contents . 1. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (QM); 2. Wave function and Schrödinger equation (SG): SG for free particles: superposition; probability distribution fo pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; sta space and Dira notation; representations in state space: tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symme try properties; 6. Spin-1/2 systems 1: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; sigenvalues of the angular momentum operators (abstract) solution of the eigenvalue equation in polar coordinates (concrete); 8. Central potential - hydrogen atom: Bonding states in 3D; Coulomb potential; 9. Moton in an electromagnetic field; Humitonian, Normal Zeeman effect; canonical and kinetic momentum; Gauge transformation; Aharonov-Bohm effect; Schrödinger, Heisenberg and interaction representation; motion of a fre electron in		and Astrophysics					
Duration Module level Other prerequisites 1 semester undergraduate Admission prerequisite to assessment: completion of exercises (approx 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginnir of the semester. Contents 1. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (OM): 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution fo pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; stat tonary solutions of 5G 3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dira notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symme try properties; 6. Spin-1/2 systems (libid); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution of the eigenvalue equation in polar coordinates (concrete); 8. Central potential - hydrogen atom: Bonding states in 3D; Coulomb potential; 9. Motion in an electromagnetic field: Hamiltonian; Normal Zeeman effect; canonical and kinetic momentum; Gauge transformation; Aharonov-Bohm effect; Schrödinger, Heisenberg and interaction representation; motion of a free electron in a magnetic field; 10. Spin-1/2 systems II: formulation using angular momentum algebra; 11. Addition of angular momenta: 12. Approximation	ECTS	Metho	od of grading	Only after succ. cor	npl. of module(s)		
I semester undergraduate Admission prerequisite to assessment: completion of exercises (approx 13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginnin of the semester. Contents I. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (QM); 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution fop pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; stat tionary solutions of SG 3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symme- try properies; 6. Spin-1/2 systems I: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution in an electromagnetic field: Hamiltonian; Normal Zeeman effect; canonical and kinetic momentum; Gauge transformation; Aharonov-Bohm effect; Schrödinger, Heisenberg and interaction representation; motion of a free electroni in amagnetic field; 10. Spin-1/2 systems II: Formulation using angular momentum algebra; 11. Addition of angular momenta: 12. Adoms with several electrons: Identical particles; Helium atom; Hartree and Hartree-Fock approximation; ato mic structure and H	8	numerical grade					
13 exercise sheets per semester). Students who successfully completed approx. 50% of exercises will qualify for admission to assessment. The lecturer will inform students about the respective details at the beginnin of the semester. Contents 1. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (QM); 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution for pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; stat tonary solutions of SG 3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dira notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symme- try properties; 6. Spin-1/2 systems I: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution of the eigenvalue equation in polar coordinates (concrete); 8. Central potential - hydrogen atom: Bonding states in 30; Coulomb potential; 9. Motion in an electromagnetic field; 10. Spin-1/2 systems I: Theoretical particles; Helium atom; Hartree and Hartree-Fock approximation; ato mic structure and Hund's rules <tr< td=""><td colspan="2">Duration Module level</td><td>Module level</td><td>Other prerequisites</td><td>i</td><th></th><th></th></tr<>	Duration Module level		Module level	Other prerequisites	i		
1. History and basics: Limits of classical physics; fundamental historical experiments; from classical physics to quantum mechanics (QM); 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution fo pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; stat to any solutions of SG 3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symmetry properties; 6. Spin-1/2 systems I: Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution of the eigenvalue equation in polar coordinates (concrete); 8. Central potential - hydrogen atom: Bonding states in 30; Coulomb potential; 9. Motion in an electromagnetic field; 10. Spin-1/2 systems II: Formulation using angular momentum algebra; 11. Addition of angular momenta: 12. Approximation methods: Stationary perturbation theory (with examples); variational method; WKB method; time-dependent perturbation theory; are able to apply the acquired mathematical method; and inctricule whow level eso functin methory; 1	1 seme:	ster	undergraduate	13 exercise sheets p approx. 50% of exe lecturer will inform	oer semester). Stude rcises will qualify for	nts who successfull admission to asses	ly completed ssment. The
quantum mechanics (QM); 2. Wave function and Schrödinger equation (SG): SG for free particles; superposition; probability distribution fo pulse measurement; correspondence principles: postulates of QM; Ehrenfest theorem; continuity equation; state ionary solutions of SG 3. Formalisation of QM: Eigenvalue equations; Physical significance of the eigenvalues of an operator; state space and Dirac notation; representations in state space; tensor products of state spaces; 4. Postulates of QM (and their interpretation): State; measurement; chronological development; energy-time un certainty; 5. One-Dimensional problems: The harmonic oscillator; potential level; potential barrier; potential well; symme- try properties; 6. Spin-1/2 systems [1 Theoretical description in Dirac notation; Spin 1/2 in the homogeneous magnetic field; two-level systems (qubits); 7. Angular momentum: Commutation and rotations; eigenvalues of the angular momentum operators (abstract) solution of the eigenvalue equation in polar coordinates (concrete); 8. Central potential - hydrogen atom: Bonding states in 3D; Coulomb potential; 9. Motion in an electromagnetic field; 10. Spin-1/2 systems II: Formulation using angular momentum algebra; 11. Addition of angular momenta: 12. Approximation methods: Stationary perturbation theory (with examples); variational method; WKB method; time-dependent perturbation theory; 13. Atoms with several electrons: Identical particles; Helium atom; Hartree and Hartree-Fock approximation; ato mic structure and Hund's rules Intended learning outcomes The students have gained first experiences concerning the working methods of Theoretical Physics. They are fa- miliar with the principles of quantum theory and to interpret the results. They have especially acquired knowledge of advanced mathematical concepts. Courses (type, number of weekly contact hours, language – if other than Geman) V (4) + Û (2) Module taught in: Û: German or English Method of assessment (type, scope, language – if oth	Conten	ts					
The students have gained first experiences concerning the working methods of Theoretical Physics. They are fa- miliar with the principles of quantum theory. They are able to apply the acquired mathematical methods and techniques to simple problems of quantum theory and to interpret the results. They have especially acquired knowledge of advanced mathematical concepts. Courses (type, number of weekly contact hours, language – if other than German) V (4) + Ü (2) Module taught in: Ü: German or English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) written examination (approx. 120 minutes) Language of assessment: German and/or English Bachelor's with 1 major Mathematical Physics JMU Würzburg • generated 30-Mär-2024 • exam. reg. da- page 25 / 160	2. Wave pulse n tionary 3. Form space a 4. Postic certaint 5. One- try prop 6. Spin two-lev 7. Angu solution 8. Cent 9. Moti Gauge f of a free 10. Spin 11. Add 12. App time-de 13. Atom mic stru	e functi neasure solutic alisatic and Dira ulates of ty; Dimens perties; -1/2 sy rel syste alar mo n of the ral pote on in a transfo e electr n-1/2 sy ition of proxima epende ms with ucture a	on and Schrödinger eq ement; correspondence ons of SG on of QM: Eigenvalue en ac notation; representa of QM (and their interpre- sional problems: The has stems I: Theoretical des ems (qubits); mentum: Commutation e eigenvalue equation i ential - hydrogen atom: n electromagnetic field rmation; Aharonov-Boh ron in a magnetic field; ystems II: Formulation of angular momenta: tion methods: Stationant perturbation theory; n several electrons: Iden and Hund's rules	e principles: postulates quations; Physical sign tions in state space; to retation): State; measu armonic oscillator; pot scription in Dirac notat and rotations; eigenva n polar coordinates (co Bonding states in 3D; Hamiltonian; Normal am effect; Schrödinger using angular moment any perturbation theory	s of QM; Ehrenfest the nificance of the eiger ensor products of sta trement; chronologic ential level; potentia tion; Spin 1/2 in the alues of the angular oncrete); Coulomb potential; Zeeman effect; canc , Heisenberg and inte um algebra; (with examples); va	riational method; W	equation; sta- tor; state ergy-time un- well; symme- netic field; ors (abstract); omentum; tion; motion /KB method;
miliar with the principles of quantum theory. They are able to apply the acquired mathematical methods and techniques to simple problems of quantum theory and to interpret the results. They have especially acquired knowledge of advanced mathematical concepts. Courses (type, number of weekly contact hours, language – if other than German) V (4) + Ü (2) Module taught in: Ü: German or English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) written examination (approx. 120 minutes) Language of assessment: German and/or English Bachelor's with 1 major Mathematical Physics JMU Würzburg • generated 30-Mär-2024 • exam. reg. da- page 25 / 160	Intende	ed learn	ning outcomes				
V (4) + Ü (2) Module taught in: Ü: German or English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) written examination (approx. 120 minutes) Language of assessment: German and/or English Bachelor's with 1 major Mathematical Physics JMU Würzburg • generated 30-Mär-2024 • exam. reg. da- page 25 / 160	miliar w techniq	vith the ques to	principles of quantum simple problems of qu	theory. They are able antum theory and to ir	to apply the acquired	d mathematical met	thods and
Module taught in: Ü: German or English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) written examination (approx. 120 minutes) Language of assessment: German and/or English Bachelor's with 1 major Mathematical Physics JMU Würzburg • generated 30-Mär-2024 • exam. reg. da- page 25 / 160	Course	S (type, n	umber of weekly contact hours	s, language — if other than Ge	rman)		
module is creditable for bonus) written examination (approx. 120 minutes) Language of assessment: German and/or English Bachelor's with 1 major Mathematical Physics JMU Würzburg • generated 30-Mär-2024 • exam. reg. da- page 25 / 160	11	• •	t in: Ü: German or Engli	sh			
Language of assessment: German and/or English Bachelor's with 1 major Mathematical Physics JMU Würzburg • generated 30-Mär-2024 • exam. reg. da- page 25 / 160				uage — if other than German,	examination offered — if no	ot every semester, informa	ition on whether
	achelor's	with 1 maj	or Mathematical Physics	JMU Würzburg •	generated 30-Mär-2024 • ex	am. reg. da-	page 25 / 160

Allocation of places

Additional information

Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's registration for assessment into effect. Only those students that meet the respective prerequisites can successfully register for an assessment. Students who did not register for an assessment or whose registration for an assessment was not put into effect will not be admitted to the respective assessment. If a student takes an assessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered.

Workload

240 h

Teaching cycle

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

Module appears in

Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor' degree (1 major, 2023) Bachelor' degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)



Subfield Statistical Physics and Electrodynamics

(16 ECTS credits)

Bachelor's with 1 major Mathematical Physics

(2024)

Module	title				Abbreviation
Statistical Physics and Electrodynamics			CS		11-T-SE-152-m01
Module	coord	inator		Module offered by	
-	Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics a	nd Astronomy
ECTS Method of grading Only after succ. compl. of module(s)					
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
2 seme	ster	undergraduate			
Conten	ts				
o. Princ cro-stat 1. Statis closed 2. Ideal 3. Stati ralised 4. Thern thermo 5. Ideal se-Eins 6. Syste ter simu 1 and 2 7. Critic BCS su o); prob B. Elect o. Math tence; I 1. Maxv 2. Elect multipo ment ac 3. Magi analogi 4. Maxv 5. Dyna waves; on; tem 6. Spec effect, 6 7. Cova ler effec	iples c tes; pro stical P and op l syster stical F forces; modyn dynam Syster tein co ems of ulation dimen cal phe percon olems of condyna condyna condyna condyna dimen cal phe percon olems of condyna condyn condyn condyn condyn c	bability space (condition hysics: Entropy and prob een systems (with energy ns: Spin systems; linear Physics and thermodynamic the second and third law amics: Thermodynamic fu- ic machines (Carnot engins II, quantum statistics: ndensation; grids and no interacting particles: App (Monte Carlo method); in sions); Yang-Lee-theorer nomena: Scaling laws, cr ductivity); magnetism (quid of the thermodynamic lim amics; cal tools: Gradient, divergunction; Fourier transform uations; cs: Coulomb's law; electra ansion; Boundary value p of to orthogonal functions titics: Current density; cor lectrostatics; uations in matter: Electric f electromagnetic fields: backets; plane waves in r y oscillating sources and ory of Relativity: Lorentz and momentum; co- and lectrodynamics: Field stree entz force hing outcomes	hal probability, statis ability theory; entrop and / or particle excl oscillators; ideal gas hics: The 1st law; qua v; reversibility; transi undamentals relation ne and efficiency); ch Systems of identical ormal modes: Phonor proximation methods hteracting phonons (ns; Van der Waals eq itical slowing down, fu antum criticality at h it; gence, curl; curve, su h; full functional syste ostatic potential; cha problems; numerical s; htinuity equation; vec cal and magnetic sus Faraday induction; R natter; cavity resonat dipole radiation; acc transform; simultane contra-variant tenso ength tensor and Max	tical independence) by in classical physic nange); sisi-static processes; ition from Statistical ship; thermodynami nemical potential; particles; ideal Fern 15; (mean-field theory, Debye approximation uation for real intera fast variable as Bad ow temperatures, qu rface, volume integra ems; solving PDEs; arged interface; elect solution; Image char ctor potential; Biot-S ceptibility; interface cL-circuits; field ene tors and wave guides elerated point charg ity; length contractio rs; covariant classica cwell's equations; tra	s; thermodynamic equilibrium in entropy and temperature; gene- Physics to thermodynamics; ic potentials; changes of state; ni gas; ideal Bose gas and Bo- Sommerfeld expansion); compu- n); lsing models (particularities in acting gases; (electron-phonon interaction and uantum phase transitions at T = als; Stokes and Gaussian sen- trostatic field energy (capacitor); rges; Green's functions; develop- avart law; magnetic moment; s; rgy and pulse; potentials; plane s; inhomogeneous wave equati- ies; on and time dilation; light cone;
		thermodynamics and stat ttribute them to bigger p		ney are able to discu	ss the acquired theoretical con-
		number of weekly contact hours, l	-	rman)	
V (4) + '					

JMU Würzburg • generated 30-Mär-2024 • exam. reg. data record Bachelor (180 ECTS) Mathematische Physik - 2024

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UNIVERSITÄT WÜRZBURG

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

oral examination of one candidate each (approx. 30 minutes) Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

180 h Teaching cycle

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

Module appears in

Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Statist	e title				Abbreviation
Statistical Physics - Exercises					11-T-SA-152-m01
Module	e coord	inator		Module offered by	
Manag	ing Dire	ector of the Institute of	Theoretical Physics	Faculty of Physics and Astronomy	
ECTS	d Astrophysics TS Method of grading Only after succ. c		npl. of module(s)		
5	1	rical grade			
	uration Module level Other prerequis		Other prerequisites		
1 seme	-	undergraduate		•	
Conten		undergraduate			
Among potenti Ising m	g others ials, qu nodels,	Principles of statistics antum statistics, Ferm critical phenomena, et	, Statistical Physics, id i and Bose gas, system	eal systems, fundam	e content of 11 T-SEV content. iental theorems, thermodynamic cles, approximation methods,
		ning outcomes		f the second state	
and are	e able t		them to the descriptio		dynamics and Statistical Physics blems of Statistical Physics and
			s, language — if other than Ge	rman)	
Ü (2) Module	e taugh	t in: Ü: German or Engl	ish		
Metho	d of ass	-		examination offered — if no	ot every semester, information on whether
		nation (approx. 120 mi	 nutes)		
		ssessment: German ar			
Allocat	tion of	olaces			
Additic	onal inf	ormation			
	ad				
Worklo					
150 h	ng cycl	e			
	ng cycl	e			
150 h Teachi i 			ons for teaching-degree progra	ammes)	
150 h Teachi i 			ons for teaching-degree progra	ammes)	
150 h Teachin Referre	ed to in	LPOI (examination regulation	ons for teaching-degree progra	ammes)	
150 h Teachin Referre Module	ed to in e appea	LPOI (examination regulati		ammes)	
150 h Teachin Referre Module Bachel	ed to in e appea or' deg	LPOI (examination regulati ars in ree (1 major) Physics (2	2015)		
150 h Teachin Referre Module Bachel Bachel	ed to in e appea or' deg or' deg	LPOI (examination regulati ars in ree (1 major) Physics (2	2015) cture Technology (2015		
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Modul	e title				Abbreviation
Electro	odynam	ics - Exercises			11-T-EA-152-m01
Modul	e coord	inator		Module offered by	
-	Managing Director of the Institute of Theoretical Physics and Astrophysics		Faculty of Physics a	and Astronomy	
ECTS			npl. of module(s)		
5	nume	rical grade			
Durati	on	Module level	Other prerequisites	;	
1 seme	ester	undergraduate			
Conte	nts		Į		
equati	ons, ele		atics, Maxwell equatio	ns in matter, dynami	s Mathematical tools, Maxwell's ic electromagnetic fields, electro-
Intend	ed lear	ning outcomes			
pende	ntly app				lynamics and are able to inde- amics and to interpret the results
Course	es (type, i	number of weekly contact hour	s, language — if other than Ge	rman)	
Ü (2) Modul	e taugh	t in: Ü: German or Engl	ish		
		s essment (type, scope, lang ble for bonus)	guage — if other than German,	examination offered — if no	ot every semester, information on whether
		nation (approx. 120 min ssessment: German ar			
Alloca	tion of	places			
Additi	onal inf	ormation			
Workle	oad				
150 h					
-	ing cycl	e			
Referr	ed to in	LPO I (examination regulati	one for teaching degree progre	ammes)	
Referr			ons for teaching-degree progra	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
Modul	e appe	ars in			
		ree (1 major) Physics (2	2015)		
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exchai	nge pro	gram Physics (2023)			

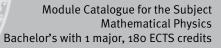


Subfield Laboratory Course Physics

(15 ECTS credits)

	e title				Abbreviation		
Labora	tory Co	urse Physics A (Mechan	ics, Heat, Electron	nagnetism)	11-P-PA-152-m01		
Modul	e coord	inator		Module offere	d by		
Manag	ing Dire	ector of the Institute of A	pplied Physics	Faculty of Phys	Faculty of Physics and Astronomy		
ECTS			compl. of module(;)			
3		successfully completed			·		
Duratio		Module level	Other prerequisi	tes			
1 seme		undergraduate					
Conter		undergraduate	1				
Measu rents, l	rement heat ca		ity of bodies, dyna	mic viscosity, elas	e.g. measurement of voltages and ticity, surface tension, spring con-		
Intend	ed learı	ning outcomes					
le to in measu	depenc ring pro	lently plan and conduct otocol.	experiments, to co	operate with othe	s, and to document the results in a		
	S (type, n	umber of weekly contact hours,	language — if other thar	German)			
P (2)							
		s essment (type, scope, langua le for bonus)	age — if other than Germ	an, examination offered	— if not every semester, information on wheth		
Prepar cessfu can be	ing, per lly com repeate	pleted if a Testat (exam) ed once. After completio	(record of readings is passed. Exactly n of all experimen	one experiment th ts, talk (with discu	experiments will be considered su at was not successfully completed ssion; approx. 30 minutes) to test		
Prepar cessfu can be candid pleted	ing, per lly com repeate ate's u	forming and evaluating oleted if a Testat (exam) ed once. After completio nderstanding of the phys repeated once. Both cor	(record of readings is passed. Exactly n of all experimen sics-related conter	one experiment th ts, talk (with discu ts of the module.	at was not successfully completed		
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Prepar cessfu can be candid pleted Allocat Additic 90 h Teachi Referre Bachel Bachel Bachel Bachel Bachel	ing, per lly com repeate ate's un can be tion of p onal info pad or deg or' deg or' deg or' deg or' deg	forming and evaluating oleted if a Testat (exam) ed once. After completio inderstanding of the physic repeated once. Both corr olaces ormation e LPO I (examination regulation ars in ree (1 major) Mathematic ree (1 major) Mathematic ree (1 major) Mathematic ree (1 major) Mathematic	(record of readings is passed. Exactly n of all experimen sics-related conter nponents of the as as for teaching-degree pr cs (2015) (20 cal Physics (2015)	one experiment the s, talk (with discults of the module. Seessment have to seessment have to orgrammes)	at was not successfully completed ssion; approx. 30 minutes) to test Talks that were not successfully co		
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Julius-Maximilians-UNIVERSITÄT WÜRZBURG



Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Aerospace Computer Science (2020) Bachelor' degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title			Abbreviation			
Data ar	nd Erro	r Analysis			11-P-FR1-152-m01	
Module	e coord	inator		Module offered by		
Managi	ng Dire	ector of the Institute of	Applied Physics	plied Physics Faculty of Physics and Astronomy		
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
2	(not) s	successfully completed				
Duration Module level Other prerequisites						
1 seme:	ster	undergraduate	13 exercise sheets p approx. 50% of exer	site to assessment: o per semester). Studen rcises will qualify for students about the re	nts who successfully admission to asses	/ completed sment. The
Conten	ts					
		s, error approximation deviation.	and propagation, grap	nic representations, l	inear regression, me	ean values
Intende	ed learı	ning outcomes				
			easuring results on the iscuss the conclusions		ation and of the prin	nciples of
Course	S (type, n	umber of weekly contact hour	s, language — if other than Ge	rman)		
V (1) + ĺ Module		t in: Ü: German or Engl	ish			
		essment (type, scope, lang le for bonus)	guage — if other than German,	examination offered — if no	t every semester, informat	on on whether
		nation (approx. 120 min ssessment: German ar				
Allocat						
Additio	nal inf	ormation				
this wil 3 Sente find tha gistration ly registive sessme	Additional information Registration: If a student registers for the exercises and obtains the qualification for admission to assessment, this will be considered a declaration of will to seek admission to assessment pursuant to Section 20 Subsection 3 Sentence 4 ASPO (general academic and examination regulations). If the module coordinators subsequently find that the student has obtained the qualification for admission to assessment, they will put the student's re- gistration for assessment into effect. Only those students that meet the respective prerequisites can successful- ly register for an assessment. Students who did not register for an assessment or whose registration for an as- sessment was not put into effect will not be admitted to the respective assessment. If a student takes an as- sessment to which he/she has not been admitted, the grade achieved in this assessment will not be considered					
Worklo	ad					
60 h						
Teachir	ıg cycl	e				
Referre	d to in	LPO I (examination regulati	ons for teaching-degree progra	ammes)		
§ 53 N § 77 N						
Module	e appea	ars in				
Bachel	or' deg	ree (1 major) Mathema ree (1 major) Physics (2 ree (1 major) Nanostrue	-)		
Bachelor's (2024)	with 1 maj	or Mathematical Physics	-	generated 30-Mär-2024 • exa r (180 ECTS) Mathematische I	-	page 35 / 160
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Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor' degree (1 major) Aerospace Computer Science (2015) Bachelor' degree (1 major) Functional Materials (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) First state examination for the teaching degree Grundschule Physics (2015) First state examination for the teaching degree Realschule Physics (2015) First state examination for the teaching degree Gymnasium Physics (2015) First state examination for the teaching degree Mittelschule Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Aerospace Computer Science (2017) First state examination for the teaching degree Grundschule Physics (2018) First state examination for the teaching degree Realschule Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor' degree (1 major) Aerospace Computer Science (2020) First state examination for the teaching degree Grundschule Physics (2020) First state examination for the teaching degree Gymnasium Physics (2020) First state examination for the teaching degree Realschule Physics (2020) First state examination for the teaching degree Mittelschule Physics (2020) Bachelor' degree (1 major) Functional Materials (2021) Bachelor' degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module	e title				Abbreviation
Labora	tory Co	ourse Physics B for Stude	ents of Mathematical	Physics	11-P-MPB-152-m01
Module	e coord	inator		Module offered by	•
Manag	ing Dire	ector of the Institute of A	oplied Physics	Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
4		successfully completed		• • • •	
Duratio		Module level	Other prerequisites		
1-2 sem	nester	undergraduate	Students are highly		mplete modules 11-P-PA and 11- IPB.
Conten	ts				
Physica	al laws	of optics, vibrations and	waves, science of ele	ectricity and circuits	with electric components.
Intende	ed lear	ning outcomes			
measu princip	ring pro		valuate the measurin esent and discuss the	g results on the bas conclusions.	nd to document the results in a is of error propagation and of the
P (2)					
practica Prepari cessful can be candid pleted	al assig ng, per ly com repeat ate's u can be	pleted if a Testat (exam) ed once. After completion nderstanding of the phys repeated once. Both com	record of readings or is passed. Exactly on n of all experiments, ics-related contents	e experiment that w talk (with discussior of the module. Talks	eriments will be considered suc- as not successfully completed n; approx. 30 minutes) to test the that were not successfully com- uccessfully completed.
Allocat	ion of _l	olaces			
Additio	nal inf	ormation	-		
Worklo	ad				
120 h					
Teachi	ng cycl	e			
Referre	d to in	LPO I (examination regulation	s for teaching-degree progra	ammes)	
Module	e appea	ars in			
	-	ree (1 major) Mathematic			
	-	ree (1 major) Mathematic	-		
	-	ree (1 major) Mathematic ree (1 major) Mathematic	•		
Dachel	oi ueg		.ai r'11ysius (2024)		

Module	e title				Abbreviation
Labora	tory Co	ourse Physics C for Stude	nts of Mathematical	Physics	11-P-MPC-152-m01
Module	e coord	inator		Module offered by	
Manag	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	and Astronomy
ECTS	Methe	od of grading	Only after succ. com	npl. of module(s)	
4	(not)	successfully completed			
Duratio	on	Module level	Other prerequisites		
1-2 sen	nester	undergraduate	Students are highly completing module		mplete module 11-P-MPB prior to
Conten	ts				
		of wave optics, Molecula ised devices with exampl			rn measuring methods using spe
Intend	ed lear	ning outcomes			
to reco by usin	rd mea Ig error	suring results in a structu	ured manner, even in cs. They are able to ev	case of huge data tr	erimental setups. They are able affic, and to analyse the results raw conclusions and to present
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)	
P (2)					
		sessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	ot every semester, information on whether
Prepari cessful can be candid	ng, pei ly com repeat ate's u	pleted if a Testat (exam) i ed once. After completior	record of readings or is passed. Exactly on n of all experiments, t ics-related contents of	e experiment that wa talk (with discussion of the module. Talks	riments will be considered suc- as not successfully completed a; approx. 30 minutes) to test the that were not successfully com- uccessfully completed.
Allocat					
Additio	nal inf	ormation			
Worklo	ad				
120 h					
Teachi	ng cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	e appea	ars in			
		ree (1 major) Mathematic	al Physics (2015)		
Bachelor' degree (1 major) Mathematical Physics (2016)					
Bachel	Bachelor' degree (1 major) Mathematical Physics (2020)				
	-				

Module	e title				Abbreviation	
Advanced and Computational Data Analysis					11-P-FR2-152-m01	
Module	e coordina	itor		Module offered by		
Manag	ing Direct	or of the Institute of A	oplied Physics	Faculty of Physics a	nd Astronomy	
ECTS	1	of grading	Only after succ. com		,	
2	<u> </u>	cessfully completed				
Duratio		odule level	Other prerequisites			
1 seme	ester ur	ndergraduate	Students are highly completing module		mplete module 11-P-FR1 prior to	
Conten	nts					
		ods of data analysis an ata analysis.	d error calculation. D	istribution function,	significance tests, modelling.	
Intend	ed learnin	g outcomes				
stered		of computerised data			error calculation. They have ma tained measuring data and to	
Course	es (type, num	ber of weekly contact hours, I	anguage — if other than Ger	rman)		
V (1) +	Ü (1)					
Metho	d of asses	sment (type, scope, langua	ge — if other than German.	examination offered — if no	t every semester, information on whethe	
	s creditable f		0 ,,		····,···, ····, ····	
Exercis	ses (succe	ssful completion of ap	prox. 50% of approx.	10 exercise sheets)		
		red: Once a year, sum		-		
Allocat	tion of pla	ces				
Additio	onal inform	nation				
Worklo	bad					
60 h						
	ng cycle					
	0 .,					
Referre	ed to in I P	OI (examination regulation	s for teaching-degree progra	mmes)		
Madul		in				
	e appears		(-)			
	-	e (1 major) Physics (20				
		e (1 major) Nanostructu		1		
	Bachelor' degree (1 major) Mathematical Physics (2015)					
Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Physics (2020)						
Rachal	Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Nanostructure Technology (2020)					
	Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020)					
Bachel	-	(1 major) Mathamatic	al Dhycics (2020)			
Bachel Bachel	lor' degree	-				
Bachel Bachel Bachel	lor' degree lor' degree	e (1 major) Functional N	Materials (2021)			
Bachel Bachel Bachel Bachel	lor' degree lor' degree lor' degree	-	Materials (2021)			

Bachelor's with 1 major Mathematical Physics	JMU Würzburg ● generated 30-Mär-2024 ● exam. reg. da-	page 39 / 160
(2024)	ta record Bachelor (180 ECTS) Mathematische Physik - 2024	



Compulsory Electives Analysis and Linear Algebra

(10 ECTS credits)



Subgroup Basics of Mathematical Methods

(5 ECTS credits)

Module title					Abbreviation	
Analysis 1 for Mathematical Physics 10-M-ANAP1-202-mo1					10-M-ANAP1-202-m01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
5	(not) s	successfully completed				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
sequer	ices an		d Taylor series; basic	cs in differential calc	convergence and divergence of culus in one variable; basics of in-	
Intende	ed lear	ning outcomes				
central	proof r	nethods in analysis and	can employ them to s	solve easy problems	He/She is acquainted with the . He/she is able to perform easy ts precisely and clearly in written	
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)		
Ü (2)						
		sessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether	
written	exercis	nation (approx. 90 to 180 ses (approx. 12 exercise s ssessment: German and,	sheets with approx. 4	exercises each)		
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	e appea	ars in				
	Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2024)					

Module title Abbreviation					Abbreviation	
Analysi	is 2 for	Mathematical Physics			10-M-ANAP2-202-m01	
Module	e coord	inator		Module offered by		
Dean o	fStudie	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
5	(not) s	successfully completed				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
	aylor's t	theorem for multivariate			ntial calculus in several varia- nverse function theorem, implicit	
Intende	ed leari	ning outcomes				
central mather form.	proof r natical	nethods in analysis and arguments independent	can employ them to s ly and to express mat	olve easy problems thematical argumen	He/She is acquainted with the . He/she is able to perform easy ts precisely and clearly in written	
	S (type, n	umber of weekly contact hours, l	anguage — if other than Gei	man)		
Ü (2)						
		s essment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether	
written written	examii exercis	nation (approx. 90 to 180 ses (approx. 12 exercise s ssessment: German and,	sheets with approx. 4	exercises each)		
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module						
Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2024)						



Subfield Lineare Algebra

(5 ECTS credits)

Module title					Abbreviation		
Linear	Linear Algebra 1 for Mathematical Physics				10-M-LNAP1-202-m01		
Module	e coord	inator		Module offered by			
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics		
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
5	(not) s	successfully completed					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts						
tion, de Intende The stu ted wit	etermin ed lear ident ki h the co	ants. ning outcomes nows and masters the ba entral proof methods in li	sic notions and esse near algebra and car	ntial methods of line	sion theorem, matrix representa- ear algebra. He/She is acquain- e easy problems. He/She is able em adequately in written form.		
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)			
Ü (2)							
		eessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether		
exercis	es eacl			n exercises (approx.	12 exercise sheets with approx. 4		
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teaching cycle							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module	e appea	ars in					
	-	ree (1 major) Mathematic	, , ,				
Bachel	Bachelor' degree (1 major) Mathematical Physics (2024)						

Module title					Abbreviation	
Linear Algebra 2 for Mathematical Physics					10-M-LNAP2-202-m01	
Module	e coord	inator		Module offered by	<u> </u>	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)		
5	(not) s	successfully completed				
Duratio		Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	Its					
diagon bases, trices.	alisabi orthog	lity, nilpotent maps, Jorda onal complement, ortogo	an normal form; Eucl	idean/unitary space	polynomial, invariant subspaces, s: scalar product, orthonormal mal matrices, positive definit ma-	
	-	ning outcomes				
ted wit	h the c	entral proof methods in li	near algebra and car	n apply them to solve	ear algebra. He/She is acquain- e easy problems. He/She is able em adequately in written form.	
Course	S (type, r	umber of weekly contact hours, l	anguage — if other than Ger	rman)	i	
Ü (2)						
		eessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether	
exercis	es eacl			n exercises (approx.	12 exercise sheets with approx. 4	
Allocat			5			
Additio	onal inf	ormation				
Worklo	ad					
150 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	e appea	irs in				
		ree (1 major) Mathematic	al Physics (2020)			
Bachelor' degree (1 major) Mathematical Physics (2020)						



Mathematical Methods

(18 ECTS credits)



Subgroup Basics of Mathematical Methods

(5 ECTS credits)

Module title					Abbreviation	
Introdu	Introduction to Differential Geometry				10-M-DGE-202-m01	
Module coordinator Module of				Module offered by	/ /	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathe	matics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
5	(not) s	successfully completed				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
surface of surfa mal sur	es in R^ aces; cu rfaces,	3; parametrisation of sur urvature; outlook to furth submanifolds.	faces, examples; fur	idamental forms (m	orsion of curves; 2-dimensional netrics, normal vector fields); area ample covariant derivatives, mini-	
The stu	dent k				fferential geometry. He/She is ac- nental proof methods indepen-	
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)		
V (4) +	Ü (2)					
		sessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if	not every semester, information on whether	
b) oral c) oral c credita Langua	examir examin ble for Ige of a	mination (approx. 90 to 1 nation of one candidate e lation in groups (groups o bonus ssessment: German and ffered: In the semester ir	ach (15 to 30 minute: of 2, 10 to 15 minutes /or English	s) or per candidate)	subsequent semester	
Allocat	ion of _l	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachiı	ng cycl	e				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	e appea	ars in				
	-	ree (1 major) Mathematic ree (1 major) Mathematic				

Module title				Abbreviation		
Ordina	ry Differ	ential Equations			10-M-DGL-202-m01	
Module	e coordir	nator		Module offered by		
Dean of	f Studies	s Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Method	d of grading	Only after succ. com	pl. of module(s)		
5	(not) รเ	accessfully completed				
Duratio	on l	Module level	Other prerequisites			
1 seme	ster ı	undergraduate				
Conten	ts					
on of co and uni dence o methoo	onstants iquenes of solutio ds, matri	s, exact equations) and r s of solutions; Gronwall ons on initial values, lin	particular examples li lemma; extendability ear differential equat autonomous systems	ke Bernoulli, Riccati of solutions, maxir ions, algebraic struc	separation of variables, variati- i; initial value problem; existence nal solution; continuous depen- cture of solution spaces, solution ; stability of linear systems; linea-	
Intende	ed learni	ing outcomes				
		acquainted with the fun she is able to apply the			neory of ordinary differential	
Course	S (type, nu	mber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) +	Ü (2)					
		e ssment (type, scope, langua for bonus)	ge — if other than German, e	examination offered — if no	ot every semester, information on whether	
b) oral c) oral c credital	examina examina ble for b	ination (approx. 90 to 1 Ition of one candidate e tion in groups (groups c onus sessment: German and/	ach (15 to 30 minutes of 2, 10 to 15 minutes	s) or		
Allocat	ion of pl	aces				
Additio	nal info	rmation				
Worklo	ad					
150 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
	e appear					
	-	ee (1 major) Mathematic	• • •			
Bachel	Bachelor' degree (1 major) Mathematical Physics (2024)					

Module title				Abbreviation		
Introdu	ction t	o Complex Analysis			10-M-FTH-202-m01	
Module	e coord	inator		Module offered by		
Dean of	fStudi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	(not) s	successfully completed				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
formati comple Cauchy tation c	ons), c x analy integra of real i	omplex integration, Cauc vsis (in particular identity al theorem, isolated sing	hy's integral theorem theorem, maximum ularities and Laurent iple, Rouche's theore	n and Cauchy's integ principle, openness series, residue theo	ps (in particular Möbius trans- ral formula, basic principles of priciple, Schwarz lemma), gneral rem and its applications (compu- (in particular Montel's theorem	
Intende	ed learı	ning outcomes				
		acquainted with the fun ethods to practical probl		nd methods in comp	olex analysis. He/she is able to	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) +	Ü (2)					
		e essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
b) oral c) oral c credital	examin examin ble for	nination (approx. 90 to 1 ation of one candidate e ation in groups (groups c bonus ssessment: German and,	ach (15 to 30 minutes of 2, 10 to 15 minutes	s) or		
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachir	Teaching cycle					
Referre	d to in	LPOI (examination regulations	s for teaching-degree progra	mmes)		
Module						
	-	ree (1 major) Mathematic	, , ,			
Bachel	Bachelor' degree (1 major) Mathematical Physics (2024)					

Module title					Abbreviation	
Geometric Analysis					10-M-GAN-202-m01	
Module	coord	inator		Module offered by		
Dean of	fStudie	es Mathematik (Mathema	atics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	(not) s	successfully completed				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	undergraduate				
Content	ts					
tial forn	ns and specia	exterior derivative; Stoke l cases Gauss' theorem a	es' theorem for differe	ential forms; Hodge	t boundary; orientation; differen- star operator; Stokes' theorem opics like density or submani-	
Intende	ed leari	ning outcomes				
		acquainted with the funder the standard states and the second stat		nd methods in geom	etric analysis. He/she is able to	
Courses	5 (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) + ĺ	Ü (2)					
			ge — if other than German, e	examination offered — if no	t every semester, information on whether	
		le for bonus)				
b) oral e c) oral e credital	examin examin ble for	nination (approx. 90 to 1 ation of one candidate e ation in groups (groups c bonus ssessment: German and/	ach (15 to 30 minutes of 2, 10 to 15 minutes	s) or		
Allocati	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module						
	-	ree (1 major) Mathematic				
Bachelor' degree (1 major) Mathematical Physics (2024)						

Module title					Abbreviation		
Introduction to Functional Analysis				10-M-FAN-202-m01			
Module	coord	inator		Module offered by			
Dean of	fStudi	es Mathematik (Mathema	atics)	Institute of Mathem	atics		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
5	(not) s	successfully completed					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts						
ty; linea ple, ope (extens glu theo thonorr theory o	Banach spaces; function spaces (L^p spaces of continuous functions, Sobolev spaces), denseness, separabili- ty; linear operators, fundamental theorems for linear operators; Baire's theorem, uniform boundedness princi- ple, open mapping theorem, closed graph theorem; linear functionals and dual spaces; Hahn-Banach theorem (extension theorem, separation theorem), double dual space and reflexivity; weak convergence, Banach-Alao- glu theorem, adjoint operator, closed range theorem; Hilbert spaces: Fréchet-Riesz representation theorem, or- thonormal systems; compact sets and operators, Arzela-Ascoli theorem; spectral theory: basic notions, spectral theory of compact normal and self-adjoint operators in Hilbert spaces.						
		ning outcomes					
method	ls, is al		n linear algebra and a	analysis to functiona	is as well as the pertinent proof al analysis, and realises the		
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)			
V (4) +	Ü (2)						
		essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether		
b) oral (c) oral (credital	examin examin ble for	nination (approx. 90 to 1 ation of one candidate e ation in groups (groups c bonus ssessment: German and,	ach (15 to 30 minutes of 2, 10 to 15 minutes	s) or			
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teachir	ng cycl	e					
Referre	d to in	LPOI (examination regulations	s for teaching-degree progra	mmes)			
Module							
	-	ree (1 major) Mathematic	, , ,				
Bachelo	Bachelor' degree (1 major) Mathematical Physics (2024)						

Module title					Abbreviation			
Introduction to Partial Differential Equations					10-M-PAR-202-m01			
Module	coord	inator		Module offered by				
Dean of	fStudi	es Mathematik (Mathema	atics)	Institute of Mathem	natics			
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)				
5	(not) s	successfully completed						
Duratio	n	Module level	Other prerequisites					
1 seme	ster	undergraduate						
Conten	ts							
transpo Dirichle near pa mula fo	Examples of partial differential equations; existence and uniqueness theorems; exact solutions for the linear transport equation, the Poisson equation, the heat equation and the wave equation; boundary value problems, Dirichlet problems; energy methods, Green's functions, maximum principle; explicit solutions for general nonlinear partial differential equations of first order; Hopf-Lax formula for Hamilton-Jacobi equations; Lax-Oleinik formula for scalar conservation laws; further methods for solving partial differential equations (e.g., separation of variables, Fourier and Laplace transformation).							
		ning outcomes						
		acquainted with the function is able to apply these me	•		neory of partial differential equa-			
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)				
V (4) +	Ü (2)							
		e essment (type, scope, langua; le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether			
b) oral c) oral c credital Langua	examin examin ble for ge of a	nination (approx. 90 to 1 ation of one candidate e ation in groups (groups c bonus ssessment: German and/ ffered: In the semester in	ach (15 to 30 minutes of 2, 10 to 15 minutes or English	s) or per candidate)	ubsequent semester			
Allocat	ion of p	olaces						
Additio	nal inf	ormation						
Worklo	ad							
150 h								
Teachir	Teaching cycle							
Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	mmes)				
Module								
	-	ree (1 major) Mathematic ree (1 major) Mathematic	• • •					
Duchell	Bachelor' degree (1 major) Mathematical Physics (2024)							



Subfield Overview Mathematical Methods

(13 ECTS credits)

Module title					Abbreviation
Overvi	ew Diffe	erential Geometry and O	rdinary Differential Ec	quations for Mathe-	10-M-DGGD-PÜ-152-m01
matica	l Physi	CS			
Modul	e coord	inator		Module offered by	
Dean o	of Studio	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
13	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ester	undergraduate			
Conter	nts				
particu face th ons on	ılar) in E eory, sı	Euclidean spaces, curvat becial classes of surfaces values, systems of linear	ure of hypersurfaces, s; existence and uniqu	geodesics, isometri ueness theorem, co	bmanifolds (hypersurfaces in es, main theorem on local sur- ntinuous dependence of soluti- Il series, linear differential equati
Intend	ed lear	ning outcomes			
dinary	differer		s able to relate these	concepts with one a	ial geometry and the theory of or- another, and realises the advan-
Course	es (type, r	number of weekly contact hours,	language — if other than Ger	man)	
V (4) +	Ü (2)				
		sessment (type, scope, langua le for bonus)	age — if other than German, e	examination offered — if no	ot every semester, information on whether
Assess may or den (O themat	sment w nly be s verview tics).	elected as the subject of	topics in pure mather one examination in th) or in module group E	he sub-field Gesamt	on with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	bad				
390 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	mmes)	
		· · · · · · · · · · · · · · · · · · ·			
Modul	e appea	ars in			
		ree (1 major) Mathematic	cal Physics (2015)		
	-		-		
Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020)					
Bachel	lor deg	ree (1 major) Mathematic	al Physics (2020)		

Module title					Abbreviation			
Overvie	Overview Complex Analysis and Differential Geometry for Mathematical Phy-				10-M-FTDG-PÜ-152-m01			
sics								
Module	e coord	inator		Module offered by				
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics			
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)				
13	nume	rical grade						
Duratio	on	Module level	Other prerequisites					
1 seme	ster	undergraduate						
Conten	ts	-						
rems, is erstraß Frenet	solated produce quatic	l singularities, meromorp ct theorem and theorem ons, local classification, s	ohic functions and Lau of Mittag-Leffler, confo submanifolds (hypers	irent series, residue ormal maps; curves urfaces in particula	grals and Cauchy integral theo- theorem and applications, Wei- in Euclidean spaces, curvature, r) in Euclidean spaces, curvature special classes of surfaces.			
Intende	ed lear	ning outcomes						
try. He/	She is		cepts with one anothe		analysis and differential geome- idvantages of thinking across the			
Course	S (type, r	umber of weekly contact hours,	language — if other than Gerr	nan)				
V (4) +	Ü (2)							
		essment (type, scope, langua le for bonus)	age — if other than German, e	xamination offered — if no	ot every semester, information on whether			
Assess may on den (Ov themat	ment w Ily be s verview ics).	elected as the subject of	topics in pure mather one examination in th) or in module group E	ne sub-field Gesamt	oon with the examiner. Each topic überblick Mathematische Metho tik (Supplementary Topics in Ma-			
Allocat	ion of p	olaces						
Additio	nal inf	ormation						
Worklo	ad							
390 h								
Teachi	ng cycl	e						
Referre	ed to in	LPO I (examination regulation	s for teaching-degree program	nmes)				
Module	e appea	irs in						
		ree (1 major) Mathematic	al Physics (2015)					
	-		• •					
Bachel	or' deg	ree (1 major) Mathematio	Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020)					
		ree (1 major) Mathematic						

Module title					Abbreviation	
Overview Complex Analysis and Ordinary Differential Equations for Mathema-			10-M-FTGD-PÜ-152-m01			
tical Pł	nysics					
Module	e coord	inator		Module offered by		
Dean o	fStudi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
13	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts		<u>I</u>			
rems, i erstraß continu al serie	solated produc uous de s, linea	l singularities, meromorp ct theorem and theorem o pendence of solutions o ar differential equations o	hic functions and Lau of Mittag-Leffler, conf n initial values, syste	urent series, residue ormal maps; exister	grals and Cauchy integral theo- theorem and applications, Wei- nce and uniqueness theorem, ntial equations, matrix exponenti-	
		ning outcomes	ontol concents and	nothodo in some	analyzia and the three of suit	
nary di	fferenti		able to relate these co	oncepts with one an	analysis and the theory of ordi- other, and realises the advanta-	
		umber of weekly contact hours, l				
V (4) +		,				
Metho	d of ass	sessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	ot every semester, information on whether	
Assess may on den (Ov themat	ment w nly be s verview tics).	elected as the subject of	topics in pure mathe one examination in t or in module group E	he sub-field Gesamt	oon with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
390 h						
Teachi	ng cycl	e				
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	mmes)		
Module	e appea	urs in				
		ree (1 major) Mathematic	al Physics (2015)			
Dather	-					
	Bachelor' degree (1 major) Mathematical Physics (2016)					
Bachel	-	ree (1 major) Mathematic ree (1 major) Mathematic				

Module title					Abbreviation	
Overview Geometric Analysis and Differential Geometry for Mathematical Phy-					10-M-GADG-PÜ-152-m01	
sics	sics					
Module	e coord	inator		Module offered by		
Dean of	f Studie	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)		
13	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
cations tion, su	in vec Ibmani	tor analysis and topology	; curves in Euclidean articular) in Euclidea	spaces, curvature, l n spaces, curvature	orms, Stoke's theorem and appli- Frenet equations, local classifica- of hypersurfaces, geodesics, iso-	
		ning outcomes				
metry. l	He/She	•	oncepts with one and	-	c analysis and differential geo- e advantages of thinking across	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) +	Ü (2)					
		s essment (type, scope, langua ₎ le for bonus)	ge — if other than German, o	examination offered — if no	t every semester, information on whether	
Assess may on den (Ov themat	ment w ly be so verview ics).	elected as the subject of	topics in pure mathe one examination in t or in module group I	he sub-field Gesamt	on with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
390 h						
Teachir	ng cycl	e				
Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	mmes)		
Module	e appea	in in				
Bachel	or' deg	ree (1 major) Mathematic	al Physics (2015)			
	-	ree (1 major) Mathematic	•			
	-	ree (1 major) Mathematic	•			
Bachel	or' deg	ree (1 major) Mathematic	al Physics (2024)			

Module ti	itle	Abbreviation		
	Geometric Analysis and Ordi	ations for Mathe-	10-M-GAGD-PÜ-152-m01	
matical P	hysics			
Module c	oordinator		Module offered by	
Dean of S	tudies Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS N	lethod of grading	Only after succ. con	npl. of module(s)	
13 N	umerical grade			
Duration	Module level	Other prerequisites		
1 semeste	er undergraduate			
Contents				
lications i ons on in	in vector analysis and topolog	y; existence and uni	queness theorem; c	orms, Stoke's theorem and app- ontinuous dependence of soluti- al series, linear differential equati-
Intended	learning outcomes			
nary diffe		able to relate these c	oncepts with one an	ic analysis and the theory of ordi- other, and realises the advanta-
Courses (type, number of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) + Ü	(2)			
	f assessment (type, scope, langua; editable for bonus)	ge — if other than German, o	examination offered — if no	ot every semester, information on whether
Assessme may only den (Over thematics	be selected as the subject of view Mathematical Methods)	topics in pure mathe one examination in t or in module group I	he sub-field Gesamt	oon with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-
Allocatio	n of places			
Additiona	ll information			
Workload	<u> </u>			
390 h				
Teaching	cycle			
Referred	to in LPO I (examination regulations	s for teaching-degree progra	mmes)	
Module a	ppears in			
	degree (1 major) Mathematic			
	degree (1 major) Mathematic	•		
	degree (1 major) Mathematic	•		
Dachelor	degree (1 major) Mathematic	ai Filysics (2024)		

Module title					Abbreviation	
Overvie	ew Geo	metric Analysis and Con	plex Analysis for Ma	thematical Physics	10-M-GAFT-PÜ-152-m01	
Module coordinator M			Module offered by			
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics	
ECTS	1	od of grading	Only after succ. con			
13	1	rical grade				
Duratio		Module level	Other prerequisites			
1 seme		undergraduate				
Conten		undergraduate	1-			
licatior path in	ns in ve tegrals	ctor analysis and topolo and Cauchy integral the	gy; complex different orems, isolated singu	iability and Cauchy-F Ilarities, meromorph	orms, Stoke's theorem and app- Riemann differential equations, ic functions and Laurent series, Mittag-Leffler, conformal maps.	
Intend	ed lear	ning outcomes				
sis. He	/She is		cepts with one anoth		c analysis and complex analy- advantages of thinking across th	
Course	S (type, r	umber of weekly contact hours,	language — if other than Gei	rman)		
V (4) +	Ü (2)					
module is	s creditab	le for bonus)		examination offered — if no	ot every semester, information on whether	
Assess may on den (O ^v themat	ment w Ily be s verview ics).	elected as the subject of	topics in pure mathe one examination in t) or in module group I	he sub-field Gesamt	on with the examiner. Each topio überblick Mathematische Metho tik (Supplementary Topics in Ma	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
390 h						
Teachi	ng cycl	e				
	5 5, 51	-				
Referre	d to in	LPO I (examination regulation	s for teaching dogroe progra	ummes)		
Module		arc in				
Module			al Dhusies (2017)			
	-	ree (1 major) Mathematio ree (1 major) Mathematio	• -			
		ree (1 major) Mathematic				
		ree (1 major) Mathematic				
Sucrici	ucs	iee (1 major) mathematic	2024			

Module title					Abbreviation	
Overview Functional Analysis and Differential Geometry for Mathematical Phy-					10-M-FADG-PÜ-152-m01	
sics	sics					
Module	coord	inator		Module offered by		
Dean of	fStudie	es Mathematik (Mathema	atics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. com	npl. of module(s)		
13	numei	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	undergraduate				
Conten	ts					
spaces,	, curvat , curvat	ure, Frenet equations, lo	cal classification, su	bmanifolds (hypersu	analysis; curves in Euclidean Irfaces in particular) in Euclidean al surface theory, special classes	
Intende	ed learr	ning outcomes				
lysis. H	e/She i	•	ncepts with one anot		al geometry and functional ana- advantages of thinking across	
Courses	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) + l	Ü (2)					
		essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
Assessi may on den (Ov themati	ment w ly be se /erview ics).	elected as the subject of	topics in pure mathe one examination in t or in module group E	he sub-field Gesamt	on with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-	
Allocati	ion of p	olaces				
Additio	nal info	ormation				
Worklo	ad					
390 h						
Teachir	ng cyclo	9				
Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	mmes)		
Module	e appea	rs in				
Bachelo	or' degi	ree (1 major) Mathematic ree (1 major) Mathematic ree (1 major) Mathematic	al Physics (2016)			
Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2024)						

Module title					Abbreviation	
Overview Functional Analysis and Ordinary Differential Equations for Mathe- matical Physics					10-M-FAGD-PÜ-152-m01	
Module coordinator Module offered by				• •		
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics	
ECTS	Meth	od of grading	Only after succ. con	pl. of module(s)		
13		rical grade		, ,,		
Duratio		Module level	Other prerequisites			
1 seme		undergraduate				
Conten						
ess the	eorem,		of solutions on initial	values, systems of	analysis; existence and uniquer linear differential equations, ma	
Intend	ed lear	ning outcomes				
nary di	fferent		able to relate these c	oncepts with one an	al analysis and the theory of ordi other, and realises the advanta-	
Course	S (type, I	number of weekly contact hours, l	anguage — if other than Ger	rman)		
V (4) +	Ü (2)					
oral ex Assess may or den (O themat	aminat aminat ment v nly be s verviev tics).	ole for bonus) ion of one candidate eacl vill have reference to two elected as the subject of	h (20 to 40 minutes) topics in pure mathe one examination in t or in module group I	matics as agreed up he sub-field Gesamt	ot every semester, information on whether boon with the examiner. Each topic tüberblick Mathematische Metho Itik (Supplementary Topics in Ma	
Allocat						
Additic	nal inf	ormation				
	-nat ini					
Worklo	hed					
390 h	au					
	nacuel	0				
Teachi	ווא נענו					
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Referre		LPO I (examination regulation	s for teaching-degree progra	immes)		
		!				
Madel	e appea					
Module	- ا- اس	waa (a maine) Marthan I'	al Dhuaisa (a = · -)			
Bachel	-	ree (1 major) Mathematic				
Bachel Bachel	or' deg	rree (1 major) Mathematic rree (1 major) Mathematic rree (1 major) Mathematic	al Physics (2016)			

Module title				Abbreviation	
Overvie	ew Fund	tional Analysis and Con	plex Analysis for Mat	thematical Physics	10-M-FAFT-PÜ-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
13	1	rical grade		• • • • •	
Duratio		Module level	Other prerequisites		
1 seme		undergraduate			
Conten		undergraduate	<u> </u>		
lity and ties, m and the	l Cauch eromor eorem c	y-Riemann differential e phic functions and Laure of Mittag-Leffler, conform	quations, path integra ent series, residue the	als and Cauchy integ	analysis; complex differentiabi- gral theorems, isolated singulari- ons, Weierstraß product theorem
Intend	ed lear	ning outcomes			
sis. He	/She is		cepts with one anothe		al analysis and complex analy- advantages of thinking across the
Course	S (type, r	umber of weekly contact hours,	language — if other than Gerr	man)	
V (4) +	Ü (2)				
module is	s creditab	le for bonus)		examination offered — if no	t every semester, information on whether
Assess may on den (Ov themat	ment w Ily be s verview ics).	elected as the subject of	topics in pure mather one examination in th) or in module group E	ne sub-field Gesamt	on with the examiner. Each topic überblick Mathematische Metho tik (Supplementary Topics in Ma
Allocat	ion of p	olaces			
Additio	onal inf	ormation			
Worklo	ad				
390 h					
Teachi	ng cycl	9	-		
	3 - 9 - 1	-			
Doforro	d to in	LPO I (examination regulation	a fartaaching daaraa ar	mmas)	
Referre		LE VI (examination regulation	is for teaching-degree program	mmes)	
		ve in			
Module			al Dhucies (as)		
	-	ree (1 major) Mathematio ree (1 major) Mathematio	• -		
	-	ree (1 major) Mathematic			
	-	ree (1 major) Mathematic	•		
Duchel	or ueg		.uti 11y5105 (2024)		

Module title					Abbreviation	
Overview Functional Analysis and Geometric Analysis for Mathematical Phy-					10-M-FAGA-PÜ-152-m01	
sics						
Module coordinator Module offered						
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
13	1	rical grade				
Duratio		Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten						
		s and Hilbert spaces bo	unded operators prir	ciples of functional	analysis; fundamentals in analy-	
					and applications in vector analy-	
sis and						
Intende	ed lear	ning outcomes				
					al analysis and geometric analy-	
			•	er, and realises the a	advantages of thinking across the	
		ferent branches in mathe				
		number of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) +						
			ge — if other than German, o	examination offered — if no	ot every semester, information on whether	
		le for bonus)				
		ion of one candidate eac vill have reference to two		matics as agreed ur	oon with the examiner. Each topic	
					überblick Mathematische Metho-	
den (O	verviev				tik (Supplementary Topics in Ma-	
themat						
		ssessment: German and,	or English			
Allocat	ion of	places				
Additio	onal inf	ormation				
Worklo	ad					
390 h						
Teachi	ng cycl	e				
Referre	ed to in	LPOI (examination regulation	s for teaching-degree progra	mmes)		
Module	e appea	ars in				
		ree (1 major) Mathematic	al Physics (2015)			
	-	ree (1 major) Mathematic				
	-	ree (1 major) Mathematic	-			
	Bachelor' degree (1 major) Mathematical Physics (2024)					

Module title					Abbreviation	
Overvi	ew Diff	erential Geometry and Pa	rtial Differential Equ	ations for Mathe-	10-M-DGPA-PÜ-152-m01	
matica	l Physi	cs				
Modul	e coord	inator		Module offered by		
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
13	nume	rical grade		-		
Duratio	on	Module level	Other prerequisites			
1 seme	ester	undergraduate				
Conten	nts		<u> </u>			
particu face th ons of	ılar) in I eory, sı first orc	Euclidean spaces, curvation pecial classes of surfaces	ure of hypersurfaces, ; examples of partial eness theorems, basi	geodesics, isometri differential equatio	bmanifolds (hypersurfaces in es, main theorem on local sur- ns and partial differential equati ematical physics, boundary valu	
Intend	ed lear	ning outcomes				
partial	differe		s able to relate these	concepts with one	ial geometry and the theory of another, and realises the advan-	
Course	es (type, r	number of weekly contact hours, l	anguage — if other than Ger	rman)		
V (4) +	Ü (2)					
		Sessment (type, scope, langua le for bonus)	ge — if other than German, o	examination offered — if no	ot every semester, information on whether	
Assess may or den (O themat	sment w nly be s verview tics).	elected as the subject of	topics in pure mathe one examination in t or in module group I	he sub-field Gesam	oon with the examiner. Each topic überblick Mathematische Metho tik (Supplementary Topics in Ma	
Allocat	tion of _l	olaces				
Additio	onal inf	ormation				
Worklo	bad					
390 h						
Teachi	ng cycl	e				
Poforra	ed to in	LPO I (examination regulation	s for teaching-degree progra	immes)		
VEIGUIG						
	e appea	ars in				
 Module	e appea lor' deg		al Physics (2015)			
 Module Bachel	lor' deg	ars in ree (1 major) Mathematic ree (1 major) Mathematic	, , ,			
 Modul e Bachel Bachel	lor' deg lor' deg	ree (1 major) Mathematic	al Physics (2016)			

Module title					Abbreviation	
	Overview Ordinary Differential Equations and Partial Differential Equations for 10-M-GDPA-PÜ-152-mo1 Mathematical Physics					
Module	coord	nator		Module offered by		
Dean of	fStudie	es Mathematik (Mathema	atics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
13	numei	ical grade				
Duratio	n	Module level	Other prerequisites			
1 semester undergraduate						
Conten	ts					
Existence and uniqueness theorem, continuous dependence of solutions on initial values, systems of linear dif- ferential equations, matrix exponential series, linear differential equations of higher order; examples of partial differential equations and partial differential equations of first order, existence and uniqueness theorems, basic equations of mathematical physics, boundary value problems, maximum principle and Dirichlet problem.						
Intende	ed learr	ning outcomes				
tial equ	ations.		these concepts with		y of ordinary and partial differen- alises the advantages of thinking	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) +	Ü (2)					
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)						
oral examination of one candidate each (20 to 40 minutes) Assessment will have reference to two topics in pure mathematics as agreed upon with the examiner. Each topic may only be selected as the subject of one examination in the sub-field Gesamtüberblick Mathematische Metho- den (Overview Mathematical Methods) or in module group Ergänzung Mathematik (Supplementary Topics in Ma- thematics). Language of assessment: German and/or English						
Allocation of places						
Additional information						
Workload						
390 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Bachelor' degree (1 major) Mathematical Physics (2015)						
Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020)						
	Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2024)					

Module title Abbreviation					Abbreviation
Overview Complex Analysis and Partial Differential Equations for Mathemati- cal Physics					
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS		od of grading	Only after succ. con	npl. of module(s)	
13		rical grade			
			Other prerequisites		
1 semester undergraduate					
Conten					
rems, is	solated		hic functions and La	urent series, residue	grals and Cauchy integral theo- theorem and applications, Wei-
Intende	ed lear	ning outcomes			
differer	ntial eq		to relate these conce	pts with one anothe	analysis and the theory of partial r, and realises the advantages of
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	rman)	
V (4) +	Ü (2)				
module is oral exa Assess may on den (Ov themat	a creditat aminat ment w ly be s verview ics).	le for bonus) ion of one candidate eac vill have reference to two elected as the subject of	h (20 to 40 minutes) topics in pure mathe one examination in t or in module group F	matics as agreed up he sub-field Gesamt	ot every semester, information on whether bon with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-
Allocat	ion of _l	places			
Additio	nal inf	ormation			
Worklo	ad				
390 h					
Teachi	ng cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	e appea	ars in			
		ree (1 major) Mathematic	al Physics (2015)		
	-	ree (1 major) Mathematic			
Bachelor' degree (1 major) Mathematical Physics (2020)					
Bachelor' degree (1 major) Mathematical Physics (2024)					

Module title Abbreviation						
Overview G	Overview Geometric Analysis and Partial Differential Equations for Mathemati- 10-M-GAPA-PÜ-152-mo1					
cal Physics						
Module coo	rdinator		Module offered by			
Dean of Stu	dies Mathematik (Mathema	atics)	Institute of Mathem	atics		
ECTS Met	hod of grading	Only after succ. con	npl. of module(s)			
13 numerical grade						
Duration Module level Other prerequisites						
1 semester	undergraduate					
Contents						
applications	s in vector calculus and top theorems, basic equations	ology, examples of fi	rst order partial diffe	forms, Stoke's theorem and its prential equations, existence and e theorems, maximum principle		
Intended lea	arning outcomes					
al differenti	The student is acquainted with fundamental concepts and methods in geometric analysis and the theory of parti- al differential equations. He/She is able to relate these concepts with one another, and realises the advantages of thinking across the borders of different branches in mathematics.					
Courses (type	e, number of weekly contact hours, l	anguage — if other than Ger	rman)			
V (4) + Ü (2)						
Method of a module is credit		ge — if other than German, o	examination offered — if no	t every semester, information on whether		
oral examination of one candidate each (20 to 40 minutes) Assessment will have reference to two topics in pure mathematics as agreed upon with the examiner. Each topic may only be selected as the subject of one examination in the sub-field Gesamtüberblick Mathematische Metho- den (Overview Mathematical Methods) or in module group Ergänzung Mathematik (Supplementary Topics in Ma- thematics). Language of assessment: German and/or English						
Allocation o	f places					
Additional i	nformation					
Workload						
390 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016)						
Bachelor' degree (1 major) Mathematical Physics (2020)						
Bachelor' degree (1 major) Mathematical Physics (2024)						

Module titleAbbreviationOverview Functional Analysis and Partial Differential Equations for Mathemati- cal Physics10-M-FAPA-PÜ-152-m01					
					Module
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS		od of grading	Only after succ. com	pl. of module(s)	
13		rical grade			
			Other prerequisites		
1 seme	ster	undergraduate			
	Contents				
ferentia	al equa	tions and partial differen	tial equations of first	order, existence and	analysis; examples of partial dif- d uniqueness theorems, basic ple and Dirichlet problem.
Intende	ed lear	ning outcomes			
tial diff	erentia		ole to relate these co	ncepts with one ano	al analysis and the theory of par- ther, and realises the advantages
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) +	Ü (2)				
module is oral exa Assess may on	aminat ment w ly be s verview	^{le for bonus)} ion of one candidate eacl <i>i</i> ill have reference to two elected as the subject of	h (20 to 40 minutes) topics in pure mathe one examination in t	matics as agreed up he sub-field Gesamt	on with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-
		ssessment: German and,	or English		
Allocat	ion of _l	olaces			
Additio	nal inf	ormation			
Worklo	ad				
390 h					
Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	e appea	ars in			
		ree (1 major) Mathematic	al Physics (2015)		
Bachelor' degree (1 major) Mathematical Physics (2016)					
Bachelor' degree (1 major) Mathematical Physics (2020)					
Bachelor' degree (1 major) Mathematical Physics (2024)					



Mathematical Physics

(18 ECTS credits)



Module Group Supplementary Topics in Mathematics

(ECTS credits)

Module title Abbreviation					Abbreviation
Numerical Mathematics 1 for Mathematical Physics 10-M-NUM1P-152-m01					10-M-NUM1P-152-m01
Modul	e coord	inator		Module offered by	, ,
Dean o	of Studi	es Mathematik (Mathen	natics)	Institute of Mather	natics
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade		-	
Duratio		Module level	Other prerequisites	i	
1 seme	ester	undergraduate			
Conter	nts				
ons, in	terpola	tion with polynomials,			quations and systems of equati- erical integration.
The stu	udent is	ning outcomes acquainted with the fu oblems and knows abo			erical mathematics, applies them
Course	es (type, r	number of weekly contact hours	, language — if other than Ge	rman)	
V (4) +	Ü (2)				
(15 to 3 Langua	30 minu	ites) or c) oral examinat ssessment: German an	ion in groups (groups		xamination of one candidate each es per candidate)
Allocat	tion of _l	places			
Additio	onal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	ons for teaching-degree progra	ammes)	
Modul	e appea	ars in			
Bachel Bachel	lor' deg lor' deg	ree (1 major) Mathemat ree (1 major) Mathemat ree (1 major) Mathemat ree (1 major) Mathemat	ical Physics (2016) ical Physics (2020)		

Module title					Abbreviation
Numerical Mathematics 2 for Mathematical Physics			natical Physics		10-M-NUM2P-152-m01
Module	e coord	inator		Module offered I	by
Dean o	f Studi	es Mathematik (Mathem	natics)	Institute of Math	ematics
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	n	Module level	Other prerequisites	;	
1 seme	ster	undergraduate			
Conten	ts	κ.	•		
		oblems, linear programr Je problems.	ning, methods for init	ial value problem	s for ordinary differential equations
Intende	ed lear	ning outcomes			
about t	heir ac		s concerning the poss		umerical mathematics and knows ation in different fields of natural
		number of weekly contact hours,	language — if other than Ge	rman)	
V (4) +	Ü (2)				
module is	creditab	ole for bonus)			if not every semester, information on whether examination of one candidate eac
(15 to 3	o minu ge of a	utes) or c) oral examinati ssessment: German and	on in groups (groups		
Allocat					
Additio	nal inf	ormation			
Worklo	ad				
300 h					
 Teachii	ng cycl	e			
Referre	d to in	LPO I (examination regulation	ns for teaching-degree progra	ammes)	
Module	e appea	ars in			
		ree (1 major) Mathemati	cal Physics (2015)		
Bachel	or' deg	ree (1 major) Mathemati	cal Physics (2016)		
Bachelor' degree (1 major) Mathematical Physics (2020)					
	-	ree (1 major) Mathemati			

Module title					Abbreviation
Stocha	stics 1	for Mathematical Physic	S		10-M-STO1P-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
10 numerical grade					
Duratio		Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten		1	<u>.</u>		
continu chastic varianc	uous di indep ce, limi	stributions: normal distri endence, elementary con t theorems: law of large n	bution, random varia ditional probability,	ble, distribution fun characteristics of dis	asure and integration theory, action, product measures and sto- stributions: expected value and
Intend	ed lear	ning outcomes			
		acquainted with fundam lems and knows about th			ics, applies these methods to
Course	S (type, 1	number of weekly contact hours, l	anguage — if other than Ge	rman)	
V (4) +	Ü (2)				
		S essment (type, scope, langua ole for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
(15 to 3	o minu age of a	utes) or c) oral examinations or c) oral examinations of c) or c) oral examinations of c) or c)	on in groups (groups		kamination of one candidate each es per candidate)
Allocat	ion of	places			
Additio	onal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulations	s for teaching-degree progra	ammes)	
Module	e appea	ars in			
		ree (1 major) Mathematic	al Physics (2015)		
	U U	ree (1 major) Mathematic	,		
	-	ree (1 major) Mathematic	-		
Bachel	or' deg	ree (1 major) Mathematic	al Physics (2024)		

Module title					Abbreviation
Stochastics 2 for Mathematical Physics10-M-ST02P-152-m01					10-M-STO2P-152-m01
Modul	e coord	inator		Module offered by	
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ester	undergraduate			
Conter	nts		• •		
Elemer	nts of d	ata analysis, statistics of	data in normal and c	other distributions, e	elements of multivariate statistics
Intend	ed lear	ning outcomes			
		acquainted with fundan and knows about the ty			s, applies these methods to prac-
Course	es (type, i	number of weekly contact hours,	language — if other than Ge	rman)	
V (4) +	Ü (2)				
		sessment (type, scope, langua le for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on whether
(15 to 3 Langua	30 minu	ites) or c) oral examinations seessment: German and	on in groups (groups		kamination of one candidate each s per candidate)
Allocat	tion of	olaces			
Additio	onal inf	ormation			
Worklo	oad				
300 h	_				
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	ammes)	
	e appea				
	-	ree (1 major) Mathematic	• -		
	-	ree (1 major) Mathematic	•		
	-	ree (1 major) Mathematic ree (1 major) Mathematic	•		
Dachel	ueg		at i flysics (2024)		

Module title					Abbreviation
Introduction to Algebra for Mathematical Physics 10-M-ALGP-152-mo1					10-M-ALGP-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathen	natics
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten	Its				
Fundar	nental	algebraic structures (gro	ups, rings, fields), Ga	lois theory.	
Intend	ed lear	ning outcomes			
		nows and masters the es ncepts in this field, and i			ebra. He/She is acquainted with ethods independently.
Course	S (type, r	number of weekly contact hours,	language — if other than Ge	rman)	
V (4) +	Ü (2)				
		sessment (type, scope, langua ile for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on whether
(15 to 3	30 minu age of a	ites) or c) oral examinations or c) oral examinations or c) oral examinations or c)	on in groups (groups		kamination of one candidate each s per candidate)
Allocat	ion of _l	olaces	-		
Additio	onal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	ammes)	
Module	e appea	ars in			
	-	ree (1 major) Mathematio	• -		
	-	ree (1 major) Mathematic			
	-	ree (1 major) Mathematic			
Bachel	or deg	ree (1 major) Mathematio	at Physics (2024)		

Module title Abbreviation					Abbreviation	
Applied	l Algeb	ora			10-M-AAL-222-m01	
Module	e coord	inator		Module offered by	1	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
10 numerical grade						
Duratio	n	Module level	Other prerequisites			
1 seme	1 semester undergraduate					
Conten	ts					
theory,	solvab	theory (particularly algeb ility of equations, cycloto of algebra and number the	omic fields, finite fiel	ds).	constructions, basics in Galois omputer algebra).	
Intende	ed lear	ning outcomes				
	ainted				ebra and its applications. He/She Idamental proof methods inde-	
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	rman)		
V (4) +	Ü (2)					
		sessment (type, scope, langua ole for bonus)	ge — if other than German, o	examination offered — if no	ot every semester, information on whether	
b) oral c) oral (examir examin ge of a	mination (approx. 90 to 1 nation of one candidate e nation in groups (groups c ssessment: German and, bonus	ach (15 to 30 minutes of 2, 10 to 15 minutes	s) or		
Allocat	ion of _l	places				
Additio	nal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	d to in	LPOI (examination regulations	s for teaching-degree progra	mmes)		
Module	e appea	ars in				
	-	ree (1 major) Mathematic		2)		
	U 1	gram Mathematics (2023) ree (1 major) Mathematic				
Dachel	oi ueg	ree (1 major) mathematic	ai Filysics (2024)			

Module title					Abbreviation
Introduction to Discrete Mathematics for Mathematical Ph			for Mathematical Phy	sics	10-M-DIMP-152-m01
Modul	e coord	inator		Module offe	red by
Dean c	of Studi	es Mathematik (Mathem	atics)	Institute of N	Nathematics
ECTS	Meth	od of grading	Only after succ. com	pl. of module	e(s)
10		rical grade		•	
Durati	on	Module level	Other prerequisites		
1 seme	ester	undergraduate			
Conter	nts	·	-		
		om combinatorics, intro 1g codes.	duction to graph theor	y (including a	pplications), cryptographic methods,
Intend	ed lear	ning outcomes			
levant	proof to		oly methods from num		discrete mathematics, masters the re- Id algebra to discrete mathematics and
Course	es (type, 1	number of weekly contact hours,	language — if other than Ger	man)	
V (4) +	Ü (2)				
module i	s creditat	le for bonus)			ed — if not every semester, information on whether oral examination of one candidate eac
(15 to <u>3</u> Langua	30 minu	utes) or c) oral examinati ssessment: German and	on in groups (groups o		
Alloca	tion of	places			
Additio	onal inf	ormation			
			-		
Worklo	bad				
300 h			_		
	ng cycl	e			
			-		
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree program	mmes)	
Modul	e appea	ars in			
Bache	lor' deg	ree (1 major) Mathemati	cal Physics (2015)		
	-	ree (1 major) Mathemati	•		
Bache	lor' deg	ree (1 major) Mathemati	cal Physics (2020)		
Bachelor' degree (1 major) Mathematical Physics (2024)					

Module title					Abbreviation
Introd	Introduction to Projective Geometry for Mathematical Phy				10-M-PGEP-152-m01
Modul	e coord	inator		Module offer	ed by
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of M	
ECTS	Meth	od of grading	Only after succ. com	pl. of module	(s)
10	nume	rical grade			
Durati		Module level	Other prerequisites		
1 semester undergraduate					
Conter	nts				
		d affine planes, projective s, dualities and polarities			argues, fundamental theorems for pro-
Intend	ed lear	ning outcomes			
		s acquainted with the fun nethods to practical prob		nd methods of	projective geometry. He/she is able to
Course	es (type, i	number of weekly contact hours,	language — if other than Ger	man)	
V (4) +	Ü (2)				
		s essment (type, scope, langua ble for bonus)	age — if other than German, e	examination offered	I — if not every semester, information on whether
(15 to 3 Assess Langua	30 minu sment c	utes) or c) oral examination offered: In the semester in assessment: German and	on in groups (groups on which the course is	of 2, 10 to 15 m	oral examination of one candidate each inutes per candidate) the subsequent semester
Alloca	tion of	places			
Additio	onal inf	ormation			
Worklo	bad				
300 h					
	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	mmes)	
Modul	e appea	ars in			
Bache	lor' deg	ree (1 major) Mathematic	al Physics (2015)		
	lor' deg				
Bache	Bachelor' degree (1 major) Mathematical Physics (2020)				
	-		al Physics (2016) al Physics (2020)		

Module title					Abbreviation	
Introd	uction t	o Number Theory for Ma	thematical Physics		10-M-ZTHP-152-m01	
Modul	e coord	linator		Module offered	l by	
Dean o	of Studi	es Mathematik (Mathem	atics)	Institute of Mat	hematics	
ECTS	Meth	od of grading	Only after succ. con	pl. of module(s))	
10		rical grade		•		
Durati		Module level	Other prerequisites			
1 seme	ester	undergraduate				
Conte			<u>I</u>			
tests a	ind met		ructure of the residue	class rings, the	orisation, modular arithmetics, prime ory of quadratic remainder, quadratic	
Intend	ed lear	ning outcomes				
		s acquainted with the fun methods and proof tech			number theory. He/she is able to em-	
Course	es (type, I	number of weekly contact hours,	language — if other than Gei	rman)		
V (4) +	Ü (2)					
module i a) writ (15 to g Langua	is creditat ten exa 30 minu	ole for bonus) mination (approx. 90 to : utes) or c) oral examinations ussessment: German and	180 minutes, usually on in groups (groups	chosen) or b) ora	- if not every semester, information on whether al examination of one candidate each nutes per candidate)	
Alloca	tion of	places				
Additi	onal inf	ormation				
Workle	oad					
300 h						
-	ing cycl	e				
	,		-			
Referr	ed to in	LPO I (examination regulation	is for teaching-degree progra	immes)		
Modul	e appea	ars in				
		ree (1 major) Mathematio	cal Physics (2015)			
	-		,			
Bache	Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020)					
	-					

Module title Abbreviation							
Optimi	Optimization for Machine Learning 10-M-OML-222-m01						
Module	e coord	inator		Module offered by	e offered by		
Dean o	of Studi	es Mathematik (Mathe	matics)	Institute of Mathem	natics		
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)			
10	1	rical grade		•			
Duratio		Module level	Other prerequisites				
1 seme	ester	undergraduate					
Conten			- I				
	Linear programming, quadratic programming, convex optimization, first order methods, application to machine learning problems such as support vector machines.						
Intend	ed lear	ning outcomes					
		acquainted with the re learning problems, bot			e to apply these meth	nods to prac-	
Course	S (type, r	number of weekly contact hour	s, language — if other than Ge	rman)			
V (4) + Module	• •	t in: German and/or En	glish				
Metho	d of ass	Sessment (type, scope, lang	guage — if other than German,	examination offered — if no	ot every semester, informati	ion on whether	
module is	s creditab	le for bonus)					
c) oral Langua Assess quent s	examin age of a		s of 2, 10 to 15 minutes nd/or English	per candidate)	s are offered and in	the subse-	
Allocat	tion of _l	places					
Additio	onal inf	ormation					
Worklo	ad						
300 h							
Teachi	ng cycl	e					
Referre	ed to in	LPO I (examination regulati	ons for teaching-degree progra	ummes)			
Module	e appea	ars in					
		ree (1 major) Economat	thematics (2022)				
	-	ree (1 major) Mathema		2)			
	-	ree (1 major) Artificial I	-	cience (2022)			
1		gram Mathematics (202	-				
1	-	ree (1 major) Artificial li ree (1 major) Economat	-	cience (2023)			
	-	ree (1 major) Mathema	_				
	-	ee (1 major) Physics Int					
	-	ree (1 major) Economat					
Bachelor's	with 1 ma	jor Mathematical Physics	IMU Würzhuro●	generated 30-Mär-2024 • ex	am. reg. da-	page 82 / 160	
(2024)		,		r (180 ECTS) Mathematische	-		



Bachelor' degree (1 major) Artificial Intelligence and Data Science (2024)

Module title Abbreviation					Abbreviation	
Introdu	Introduction to Mathematical Logic 10-M-LOGP-232-mo1					
Module	Module coordinator Module offered by					
Institute of Mathematics					atics	
ECTS Method of grading Only after succ. compl. of module(s)						
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster					
Conten	ts					
Intende	ed learı	ning outcomes				
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) +	Ü (2)					
Module	e taugh	t in: German and/or Engl	ish			
			ge — if other than German, e	examination offered — if no	t every semester, information on whether	
		le for bonus)				
		mination (approx. 90 to 1 tes) or c) oral examinatio			amination of one candidate each	
		ssessment: German and		of 2, 10 to 15 minutes	s per calididate)	
Credita						
Assess	ment o	ffered: In the semester in	which the course is	offered and in the fo	llowing semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	mmes)		
Module	appea	irs in				
Bachel	or' deg	ree (1 major) Mathematic	al Data Science (202	2)		
	-	ree (1 major) Mathematic	, , ,			
Bachel	Bachelor' degree (1 major) Artificial Intelligence and Data Science (2024)					

Module title					Abbreviation
Introdu	uction t	o Differential Geometry	for Mathematical Phy	sics	10-M-DGEP-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics
ECTS	Meth	od of grading	Only after succ. com	pl. of module(s)	
10		rical grade			
Duratio		Module level	Other prerequisites		
1 seme	-	undergraduate			
Conten		undergraduite			
particu	lar) in I	•	ure of hypersurfaces,		bmanifolds (hypersurfaces in es, main theorem on local sur-
Intend	ed lear	ning outcomes			
	ed with				erential geometry. He/She is ac- ental proof methods indepen-
Course	S (type, r	number of weekly contact hours,	language — if other than Ger	man)	
V (4) +	Ü (2)				
		sessment (type, scope, langua le for bonus)	age — if other than German, e	examination offered — if no	ot every semester, information on whether
may or den (O themat Assess	ment w nly be s verview tics). ment o age of a	vill have reference to a to elected as the subject of Mathematical Methods ffered: In the semester in ssessment: German and	one examination in t) or in module group E n which the course is	he sub-field Gesamt Ergänzung Mathema	with the examiner. Each topic überblick Mathematische Metho tik (Supplementary Topics in Ma ıbsequent semester
Allocat	ion of _l	olaces			
Additio	onal inf	ormation			
Worklo	ad				
300 h					
300 h Teachi	ng cycl	e			
-	ng cycl	e			
Teachi			s for teaching-degree progra	mmes)	
Teachi		e LPOI (examination regulation	is for teaching-degree progra	mmes)	
Teachi Referre	ed to in	LPOI (examination regulation	is for teaching-degree progra	mmes)	
Teachi Referre Module	ed to in e appea	LPO I (examination regulation		mmes)	
Teachi Referre Module Bachel	ed to in e appea or' deg	LPOI (examination regulation	cal Physics (2015)	mmes)	
Teachi Referre Module Bachel Bachel	ed to in e appea or' deg or' deg	LPOI (examination regulation ars in ree (1 major) Mathematio	cal Physics (2015) cal Physics (2016)	mmes)	

Module	e title				Abbreviation
Ordina	ry Diffe	rential Equations for Ma	thematical Physics		10-M-DGLP-152-m01
Module	e coord	inator		Module offered by	1
Dean o	fStudi	es Mathematik (Mathem	atics)	Institute of Mathem	natics
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten	ts		•		
		uniqueness theorem; co tions, matrix exponentia			tial values, systems of linear dif- gher order.
Intende	ed lear	ning outcomes			
		acquainted with the fun /she is able to apply the			heory of ordinary differential
Course	S (type, r	umber of weekly contact hours,	language — if other than Ge	rman)	
V (4) +	Ü (2)				
		eessment (type, scope, langua le for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on whether
may on den (Ov themat	Ily be s verview ics). Ige of a	elected as the subject of Mathematical Methods ssessment: German and	one examination in t) or in module group I	he sub-field Gesamt	with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-
Allocat	ion of p	olaces			
Additio	onal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	immes)	
Module	e appea	in in			
Bachel Bachel	or' deg or' deg	ree (1 major) Mathematic ree (1 major) Mathematic ree (1 major) Mathematic ree (1 major) Mathematic	al Physics (2016) al Physics (2020)		
	-	ree (1 major) Mathematio ree (1 major) Mathematio	•		

Module	e title				Abbreviation
Introdu	ction t	o Complex Analysis fo	r Mathematical Physics	5	10-M-FTHP-152-m01
Module	coord	inator		Module offered by	
Dean o	fStudi	es Mathematik (Mathe	matics)	Institute of Mathen	natics
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
10		rical grade		• • • •	
Duratio		Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten					
rems, is	solated	l singularities, meromo		urent series, residue	grals and Cauchy integral theo- theorem and applications, Wei-
Intende	ed lear	ning outcomes			
		acquainted with the f ethods to practical pro		nd methods in com	plex analysis. He/she is able to
Course	S (type, r	number of weekly contact hou	rs, language — if other than Ge	rman)	
V (4) +	Ü (2)				
		eessment (type, scope, lan le for bonus)	guage — if other than German,	examination offered — if no	ot every semester, information on whether
may on den (Ov themat	ly be s /erview ics). ge of a	elected as the subject Mathematical Method ssessment: German an	of one examination in t ds) or in module group l	he sub-field Gesam	with the examiner. Each topic überblick Mathematische Metho tik (Supplementary Topics in Ma
Allocat					
Additio	nal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cvcl	e			
		-			
Deferre	d to in		·		
	u (V III	P() (examination regulat	ions for feaching degree progre		
		LPO I (examination regulat	ions for teaching-degree progra	immes)	
			ions for teaching-degree progra	immes)	
 Module	e appea	urs in		immes)	
 Module Bachel	appea or' deg	irs in ree (1 major) Mathema	tical Physics (2015)	immes)	
 Module Bachele Bachele	e appea or' deg or' deg	irs in ree (1 major) Mathema ree (1 major) Mathema	tical Physics (2015) tical Physics (2016)	immes)	
 Module Bachele Bachele Bachele	e appea or' deg or' deg or' deg	irs in ree (1 major) Mathema	tical Physics (2015) tical Physics (2016) tical Physics (2020)	immes)	

Module	e title				Abbreviation
Geome	etric An	alysis for Mathematical I	Physics		10-M-GANP-152-m01
Module	e coord	inator		Module offered by	
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)	
10	1	rical grade		•	
Duratio		Module level	Other prerequisites		
1 seme	ester	undergraduate			
Conten			<u> </u>		
Fundar	nentals	in analysis on manifolds tor analysis and topology		ulus of differential f	orms, Stoke's theorem and appli-
Intend	ed lear	ning outcomes			
		acquainted with the fun ethods to practical probl		nd methods in geon	netric analysis. He/she is able to
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) +	Ü (2)				
		Sessment (type, scope, langua le for bonus)	ge — if other than German, o	examination offered — if no	ot every semester, information on whether
			ach (15 to 20 minutor	s) or b) oral oxamina	tion in groups of 2 candidates (10
may on den (O themat Langua	ment w nly be s verview tics).	vill have reference to a to elected as the subject of Mathematical Methods) ssessment: German and	one examination in t or in module group I	he sub-field Gesamt	with the examiner. Each topic überblick Mathematische Metho- tik (Supplementary Topics in Ma-
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	mmes)	
Module	e appea	urs in			
Bachel	or' deg	ree (1 major) Mathematic	al Physics (2015)		
	-	ree (1 major) Mathematic	-		
	-	ree (1 major) Mathematic	•		
Bachel	or' deg	ree (1 major) Mathematic	al Physics (2024)		

Module	e title				Abbreviation			
Introdu	uction t	o Functional Analysi	s for Mathematical Phys	sics	10-M-FANP-152-m01			
Module	e coord	inator		Module offered by	,			
Dean o	f Studi	es Mathematik (Math	nematics)	Institute of Mathe	matics			
ECTS	Meth	od of grading	Only after succ. co	mpl. of module(s)				
10		rical grade		• • • •				
Duratio		Module level	Other prerequisite	S				
1 seme	ster	undergraduate						
Conten			I					
		s and Hilbert spaces	, bounded operators, pr	inciples of functiona	Il analysis.			
		ning outcomes	· · · · · · · · · · · · · · · · · · ·)··			
method broad a	ds, is a applica	ble to apply methods bility of the theory to	from linear algebra and other branches of math	l analysis to function ematics.	vsis as well as the pertinent proof nal analysis, and realises the			
		number of weekly contact ho	ours, language — if other than G	erman)				
V (4) +	Ü (2)							
			anguage — if other than German	, examination offered — if r	not every semester, information on whether			
		le for bonus)			ation in groups of 2 candidates (10			
to 15 m Assess may or den (O ^r themat	inutes ment w aly be s verview cics). age of a	each) vill have reference to elected as the subjec v Mathematical Meth ssessment: German	a topic in pure mathema at of one examination in ods) or in module group	atics as agreed upon the sub-field Gesarr	with the examiner. Each topic htüberblick Mathematische Metho atik (Supplementary Topics in Ma			
Allocat	ion of _l	places						
Additio	onal inf	ormation						
Worklo	ad							
300 h			A					
Teachi	ng cycl	e						
Referre	ed to in	LPO I (examination regul	ations for teaching-degree prog	rammes)				
Module	e appea	ars in						
			natical Physics (2015)					
	0	. , ,	,					
	-		•	Bachelor' degree (1 major) Mathematical Physics (2016)				
Dacher	0	ice (I major) matrici	natical Physics (2020)					

Module	title				Abbreviation
Introdu	ction t	o Partial Differential Equ	ations for Mathemati	ical Physics	10-M-PARP-152-m01
Module	e coord	inator		Module offered	l by
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mat	thematics
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s))
10	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten			<u>.</u>		
	orems,	basic equations of math			of first order, existence and uniquen- oblems, maximum principle and Di-
Intende	ed lear	ning outcomes			
		acquainted with the fun is able to apply these me	•		he theory of partial differential equa-
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) +	Ü (2)				
a) oral to 15 m Assess may on den (Ov themat Assess Langua credita Allocat	examir inutes ment w ly be s verview ics). ment o ge of a ble for ion of j	each) vill have reference to a to elected as the subject of Mathematical Methods) ffered: In the semester ir ssessment: German and bonus	pic in pure mathemat one examination in t or in module group E which the course is	tics as agreed up he sub-field Ges Ergänzung Mathe	nination in groups of 2 candidates (1 con with the examiner. Each topic samtüberblick Mathematische Metho ematik (Supplementary Topics in Ma ne subsequent semester
Additio	nal inf	ormation			
	- 4				
Worklo	ad				
300 h	-				
Teachi	ıg cycl	e			
	• • •				
Referre	d to in	LPO I (examination regulation	s for teaching-degree progra	mmes)	
Module					
	-	ree (1 major) Mathematic	• -		
	-	ree (1 major) Mathematic	, , ,		
	-	ree (1 major) Mathematic ree (1 major) Mathematic	•		
Duchel	or ucg		(2024)		

Modul	e title				Abbreviation
Modell	ing an	d Computational Science	2		10-M-MWR-222-m01
Modul	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	•	Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten	ts		1		
scaling ons, fu near eo	the mondame ndame quation	odelling, asymptotic ser ntal methods for numer is.	es, classical methods	for solving ordinary	rinciples of modelling, aspects or and partial differential equati- ns and the resulting systems of l
Intend	ed lear	ning outcomes			
		nasters the fundamental ng sciences on a compu		ds and techniques to	o simulate processes from natur
Course	S (type, 1	number of weekly contact hours,	language — if other than Ge	rman)	
V (4) +					
		t in: German and/or Eng			
		sessment (type, scope, langu ble for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on whether
b) oral c) oral Langua	examir examir age of a ment o semest	er	each (15 to 30 minute of 2, 10 to 15 minutes I/or English	s) or per candidate)	es are offered and in the subse-
Allocat	ion of	places			
Additio	onal inf	ormation			
Worklo 300 h	du				
Joo II Teachi		A			
	is cycl	C			
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree progra	ummes)	
Module		ars in			
Master Bachel exchar	's degr or' deg ige pro	ee (1 major) Functional N ree (1 major) Mathemati gram Mathematics (202	cal Data Science (202 3)	2)	
Rachal	or' deg	ree (1 major) Mathemati	cal Dhycics (2021)		



Module Group Experimental Physics

(ECTS credits)

Module title				Abbreviation	
Optics and Waves				11-E-O-152-m01	
Module	Module coordinator Module offered by				
Manag	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	and Astronomy
ECTS Method of grading Only after succ. co		Only after succ. con	npl. of module(s)		
8	nume	erical grade			
Duratio	on	Module level	Other prerequisites		
1 semester undergraduate					
Contents					
-			. –		inciple: reflection, refraction. I frequency-dependent dielectric

 Light (inked to 11-E-E): basic concepts, the speed of light, Huygens-Freshel principle: reflection, reflaction, 2. Light in matter: propagation velocity in the medium; dispersion, complex and frequency-dependent dielectric constant; absorption, Kramers-Kronig relation, interfaces, Freshel equations, polarization, generation by absorption, birefringence, optical activity (dipole)

3. Geometrical optics: basic concepts, Fermat's principle, optical path, planar interfaces, Snell's law, total reflection, optical tunneling, evanescent waves, prism; normal and anomalous dispersion, curved interfaces, thin and thick lenses, lens systems, lens grinder formula, aberrations, imaging errors (spherical & chromatic aberration, astigmatism, coma, distortion, correction approaches).

4. Optical instruments: characteristics; camera, eye, magnifying glass, microscope, telescope types, bundle beam vs. image construction (electron lenses, electron microscope), confocal microscopy.

5. Wave optics: spatial and temporal coherence, Young's double slit experiment, interference pattern (intensity profile), thin films, parallel layers, wedge-shaped layers, phase shift, Newton rings, interferometer (Michelson, Mach-Zender, Fabry-Perot).

6. Diffraction in the far field: Fraunhofer diffraction, , single slit, intensity distribution, apertures, resolving power, Rayleigh & Abbé criterion, Fourier optics, optical grating, n-fold slit, intensity distribution, grating spectrometer and resolution, diffraction off atomic lattices, convolution theorem.

7. Diffraction in the near field: Fresnel, near-field diffraction at circular apertures/disks, Fresnel zone plate, near-field microscopy, holography, Huygens-Fresnel concept; white light hologram.

8. Failure of classical physics I - from light wave to photon: black body radiation and Planck's quantum hypothesis; photoelectric effect and Einstein's explanation, Compton effect, light as a particle, wave-particle duality, , quantum structure of nature

9. Failure of classical physics II - particles as waves: de Broglie's matter wave concept; diffraction of particle waves (Davisson-Germer-experiment, double slit interference).

10. Wave mechanics: wave packets, phase and group velocity (recap of 11-EM), uncertainty principle, Nyquist-Shannon theorem, wave function as probability amplitude, probability of residence, measurement process in quantum mechanics (double-slit experiment & which-way information, collapse of the wave function, Schrödinger's cat).

11. Mathematical concepts of quantum mechanics: Schrödinger equation as wave equation, conceptual comparison to wave optics, free particle and particles in a potential, time-independent Schrödinger equation as eigenvalue equation, simple examples in 1D (potential step, potential barrier and tunnel effect, box potential and energy quantization, harmonic oscillator), box potential in higher dimensions and degeneracy, formal theory of QM (states, operators, observables).

Intended learning outcomes

The students understand the basic principles and contexts of radiation, wave and quantum optics. They understand the theoretical concepts and know the structure and application of important optical instruments and measuring methods. 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)

V (4) + Ü (2)

Module taught in: Ü: German or English

Bachelor's with 1 major Mathematical Physics	
(2024)	

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Mothod of accomment (
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 120 minutes)
Language of assessment: German and/or English
Allocation of places
Additional information
Workload
240 h
Teaching cycle
Referred to in LPO I (examination regulations for teaching-degree programmes)
Module appears in
Bachelor' degree (1 major) Mathematics (2015)
Bachelor' degree (1 major) Mathematical Physics (2015)
Bachelor' degree (1 major) Computational Mathematics (2015)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015)
Bachelor' degree (1 major) Mathematical Physics (2016)
Bachelor' degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020)
Bachelor' degree (1 major) Mathematics (2023)
exchange program Physics (2023)
Bachelor' degree (1 major) Mathematical Physics (2024)

Module title Abbreviation					Abbreviation
Atoms and Quanta				11-E-A-152-m01	
Module	e coord	inator		Module offered by	
Manag	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	nd Astronomy
ECTS	Methe	od of grading	Only after succ. compl. of module(s)		
8	8 numerical grade				
Duration Module level Oth		Other prerequisites			
1 semester undergraduate					
Conten	Its				

 Structure of atoms: Experimental evidence for the existence of atoms, size of the atom, charges and masses in the atom, isotopes, internal structure, Rutherford experiment, instability of the "classical" Rutherford atom.
 Quantum mechanical foundations of Atomic Physics (short recap of part A.): Light as particle beam, particles as waves, wave functions and probability of presence, uncertainty relation and stability of atoms, energy quantisation in atoms, Franck-Hertz experiment, atomic spectra, Bohr's model and its limitations, non-relativistic Schrödinger equation.

3. The non-relativistic hydrogen atom: Hydrogen and hydrogen-like atoms, central potential and angular momentum in QM, Schrödinger equation of the H-atom, atomic orbitals: Radial and angular wave functions, quantum numbers, energy eigenvalues.

4. Atoms in external fields: orbital magnetic dipole moment, gyromagnetic ratio, magentic fields: normal Zeeman effect, electrical fields: Stark effect.

5. Fine and hyperfine structure: Electron spin and magnetic spin moment, Stern-Gerlach experiment, Einstein-de Haas effect, glimpse of the Dirac equation (spin as a relativistic phenomenon and existence of antimatter), electron spin resonance (ESR), spin-orbit interaction, relativistic fine structure, Lamb shift (quantum electrodynamics), nuclear spin and hyperfine structure.

6. Multi-electron atoms: Helium atom as simplest example, indistinguishability of identical particles, (anti)symmetry with respect to particle exchange, fermions and bosons, relation to spin, Pauli principle, orbital and spin wave function of two-particle systems (spin singlets and triplets), LS- and jj-coupling, Periodic Table of the Elements, Aufbau principles and Hund's rules.

7. Light-matter interaction: Time-dependent perturbation theory (Fermi's Golden Rule) and optical transitions, matrix elements and dipole approximation, selection rules and symmetry, line broadening (lifespan, Doppler effect, collision broadening), atomic spectroscopy.

8. Laser: Elementary optical processes (absorption, spontaneous and stimulated emission), stimulated emission as light amplification, Einstein's rate equations, thermal equilibrium, non-equilibrium character of a laser: Rate equations, population inversion and laser condition, basic structure of a laser, optical pumping, 2-, 3- and 4-level lasers, examples (ruby laser, He-Ne laser, semiconductor laser).

9. Inner-shell excitations and X-ray physics: Generation of x-radiation, bremsstrahlung and characteristic spectrum, X-ray emission for elemental analysis (EDX), X-ray absorption and contrast formation in X-ray images, X-ray photoemission, non-radiative Auger processes, synchrotron radiation, application examples.

10. Molecules and chemical bonding: Molecular hydrogen ion (H2+) as simplest example: Rigid molecule approximation and LCAO approach, bonding and anti-bonding molecular orbitals, hydrogen molecule (H2): Molecular orbital vs. Heitler-London approximation, diatomic heteronuclear molecules: covalent vs. ionic bonding, van der Waals bonds and Lennard-Jones potential, (time allowing: conjugated molecules).

11. Molecule rotations and vibrations: Born-Oppenheimer approximation, energy levels of the rigid rotator (symmetric and asymmetrical molecules), centrifugal expansion, molecule as (an)harmonic oscillator, Morse potential, normal modes, vibrational-rotational interaction.

12. Molecular spectroscopy: Transition matrix elements, vibrational spectroscopy: Infrared spectroscopy and Raman effect, vibrational-rotational transitions: Fortrat diagram, electronic transitions: Franck-Condon principle.

Intended learning outcomes

The students understand the basic principles and contexts of quantum phenomena as well as Atomic and Molecular Physics. They understand the ideas and concepts of quantum theory and Astrophysics and the relevant experiments to observe and measure quantum phenomena. They are able to apply mathematical methods to the

Bachelor's with 1 major Mathematical Physics	JMU Würzburg • generated 30-Mär-2024 • exam. reg. da-	page 95 / 160
(2024)	ta record Bachelor (180 ECTS) Mathematische Physik - 2024	

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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)
V (4) + Ü (2) Module taught in: Ü: German or English
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 120 minutes) Language of assessment: German and/or English
Allocation of places
Additional information
Workload
240 h
Teaching cycle
Referred to in LPO I (examination regulations for teaching-degree programmes)
-
Module appears in
Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major, 2 minor) Physics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020)
Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor' degree (1 major) Mathematics (2023) exchange program Physics (2023)

Bachelor' degree (1 major) Mathematical Physics (2024)

Module title					Abbreviation		
Introduction to Solid State Physics				11-E-F-152-m01			
Module coordinator				Module offered by			
Managi	ing Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. com	npl. of module(s)			
8	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts						
Somme deman 2. Cryst tice def tronic p 3. The r theory: 4. Struc electron 5. lattic branch exampl 6. Thern therma 7. Elect strongly on	Contents1. The free-electron gas (FEG), free electrons; density of states; Pauli principle; Fermi-Dirac statistics; spec. heat, Sommerfeld coefficient; electrons in fields: Drude-Lorentz-Sommerfeld; electrical and thermal conductivity, Wie- demann-Franz law; Hall effect; limitations of the model2. Crystal structure, periodic lattice; types of lattices; Bravais lattice; Miller indices; simple crystal structures; lat- tice defects; polycrystals; amorphous solids; group theoretical approaches, the importance of symmetry for elec- tronic properties3. The reciprocal lattice (RG), motivation: Diffraction; Bragg condition; definition; Brillouin zones; diffraction theory: Scattering; Ewald construction; Bragg equation; Laue's equation; structure and form factor 4. Structure determination, probes: X-ray, electron, neutron; methods: Laue, Debye-Scherrer, rotating crystal; electron diffraction, LEED5. lattice vibrations (phonons), equations of motion; dispersion; group velocity; diatomic base: optical, acoustic branch; quantisation: Phonon momentum; optical properties in the infrared; dielectric function (Lorentz model); examples of dispersion curves (occ. Kramers-Kronig), measurement methods6. Thermal properties of insulators, Einstein and Debye model; phonon density of states; anharmonicity and thermal expansion; thermal conductivity; Umklapp processes; crystal defects 7. Electrons in a periodic potential, Bloch theorem; band structure; approximation of nearly free electrons (NFE); strongly bound electrons (tight binding, LCAO); examples of band structures, Fermi surfaces, spin-orbit interacti- on8. Superconductivity, BCS theory, pairing, coupling of bosonic and fermionic modes, band structure, many-par-						
Intende	ed learı	ning outcomes					
The students understand the basic contexts and principles of Solid-State Physics (bonding and structure, lattice dynamics, thermal properties, principles of electronic properties (free electron gas)). They understand the structure of solids and know the experimental methods and theoretical models for the description of phenomena of Solid-State Physics. 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.							
Course	S (type, n	number of weekly contact hours, l	anguage — if other than Ger	man)			
V (4) + Ü (2) Module taught in: Ü: German or English							
	Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus)						
	written examination (approx. 120 minutes) Language of assessment: German and/or English						
Allocation of places							
Additio	nal inf	ormation					
Worklo	ad						
240 h	240 h						

Teaching cycle

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

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Module appears in

Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Nanostructure Technology (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor' degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Mathematics (2023) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title				Abbreviation		
Nuclear and Elementary Particle Physics				11-E-T-152-m01		
Module coordinator				Module offered by		
Managi	ng Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
 Overview, historical introduction, history and significance of Nuclear and Particle Physics Methods of Nuclear Physics, scattering and spectroscopy, nuclear radius, composition of matter, mass and charge distribution in the nucleus, the discovery of the proton and neutron Nuclear models, the mass of the atomic nuclei, droplet model, bonding energy, nuclear shell model Structure of cores, angular momentum, spin, parity, mag. and electr. moments, collective excitation forms, spin-orbit interaction Radioactivity and spectroscopy, radioactive decay, natural and civilisational sources of ionising radiation Nuclear energy, nuclear fission, nuclear reactors, nuclear fusion, star power, star development, formation of the chemical elements of hydrogen Radiation and matter, interaction of radiation and matter, Bethe-Bloch formula, photoelectric effect, pair production Instruments, accelerators and detectors Electromagnetic interaction, differential cross section, virtual photons, Feynman graphs, exchange interaction Strong interaction, quarks, gluons, colour and degree of freedom, deep-inelastic electron-proton scattering, confinement, asymptotic freedom, particle zoo, isospin, strangeness, SU (3) symmetry, antiprotons Weak interaction, cracked mirror symmetries, Wu experiment, charge conjugation, time reversal, CP invariance, exchange particles, W and Z, neutrinos, neutrino vibrations Standard model, three families of leptons and quarks, quark-lepton symmetry, Higgs boson, free parameters 						
The stu They ha	dents u ave an o	ling outcomes understand the basic c overview of the experin				
scribe t						
V (3) + I	Ü (1)	umber of weekly contact hour t in: Ü: German or Engl		man)		
		essment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether
written examination (approx. 120 minutes) Language of assessment: German and/or English						
Allocation of places						
Additional information						
Workload						
180 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
<u></u>						
Bachelor's (2024)	with 1 maj	or Mathematical Physics	_	generated 30-Mär-2024 • exa r (180 ECTS) Mathematische F	-	page 99 / 160

Module appears in

Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor' degree (1 major, 1 minor) Physics (2023) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)



Module Group Supplementary Topics in Physics

(ECTS credits)

Module title					Abbreviation	
Introduction to Relativistic Physics and Classical Field The				ory	11-RRF-202-m01	
Module coordinator				Module offered by	1	
Manag		ector of the Institute of	Theoretical Physics	Faculty of Physics a	and Astronomy	
ECTS		od of grading	Only after succ. cor	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites	5		
1 seme	ster	undergraduate				
Conten	ts					
basic c Theory as elen	oncept , Conse nentary	s of classical field the rvation Quantities, Cu foundations of the ge	lativity, relativistic mec ory using the example or rrents and Noether The neral relativity theory fo	of the scalar field. Ele orem. Elements of re	ectrodynamics as Re elativistic hydrodyna	lativistic Field
Intend	ed lear	ning outcomes				
in cova basics the Ma	of gene ster's p	presentation. Safe ha ral relativity. The stud rogram.	ial relativity and standa ndling of classical relat ents should be prepare	ivistic field theories d for further elective	as well as a rough ov	verview of the
		umber of weekly contact hou	rs, language — if other than Ge	rman)		
V (3) + Module		t in: German or Englisł	1			
		e ssment (type, scope, lan le for bonus)	guage — if other than German,	examination offered — if no	ot every semester, informat	ion on whether
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: German and/or English Assessment offered: Once a year, summer semester						
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
180 h						
Teaching cycle						
Referre	ed to in	LPO I (examination regulat	ions for teaching-degree progr	ammes)		
Module	e appea	in in				
		ree (1 major) Physics (1	2020)			
Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020)						
	or' deg	ree (1 major) Mathema				



Bachelor' degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title					Abbreviation		
Introduction to Quantum Computing and Quantum Informa				tion	11-QUI-202-m01		
Module coordinator			Module offered by				
Managi and Ast		ector of the Institute of sics	Theoretical Physics	Faculty of Physics	and Astronomy		
ECTS	. ,	od of grading	Only after succ. cor	npl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites	5			
1 seme	ster	undergraduate					
Conten	ts						
by dens ment, a of quar	Basic concepts of quantum theory and statistics. Qubits and the representation of quantum-mechanical states by density operators. Theory of the measurement process. Von Neumann entropy, bipartite systems, entangle- ment, and entanglement measures. Quantum channels, Kraus operators and Stinespring theorem. Decoherence of quantum states. Introduction to quantum teleportation and quantum cryptography. First steps in the theory of quantum computation and error correction.						
Intende	ed lear	ning outcomes					
of spec possibl	ific pro le appl	the basic principles of perties of quantum sys cations of quantum inf bject in the Master's st	tems such as entangle ormation theory. The a	ement. Overview of t	he most important tl	heorems and	
Course	S (type, r	umber of weekly contact hours	s, language — if other than Ge	rman)			
V (3) + Module		t in: German or English					
		s essment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if n	ot every semester, informat	tion on whether	
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: German and/or English Assessment offered: In the semester in which the course is offered and in the subsequent semester							
Allocat	ion of _l	olaces					
Additio	nal inf	ormation					
Worklo	ad						
180 h							
Teaching cycle							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appears in							
Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Nanostructure Technology (2020)							
Bachelor's	with 1 ma	or Mathematical Physics	JMU Würzburg ta record Bachelo	• generated 30-Mär-2024 • e	kam. reg. da-	page 104 / 160	

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title					Abbreviation		
Group Theory			11-GRT-152-m01				
Module coordinator			Module offered by				
Managi	ng Dire	ector of the Institute of	Theoretical Physics	Faculty of Physics a	and Astronomy		
and Ast	rophys	sics	- F				
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites	i			
1 semes	ster	graduate					
Conten	ts		-				
Group t	heory.	Finite groups. Lie group	os. Lie algebra. Depicti	on. Tensors. Classifi	cation theorem. App	lications.	
		ning outcomes					
The stu group t	dents l heory a	know the basics of grou and to solve them by us cessing of physical pro	ing the acquired meth				
Courses	5 (type, r	number of weekly contact hours	s, language — if other than Ge	rman)			
V (2) + I Module		t in: German or English					
		Sessment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	ot every semester, informat	ion on whether	
written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: German and/or English Allocation of places 							
Worklo	ad						
180 h							
Teachir	ıg cycl	e					
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appears in							
Bachelor' degree (1 major) Physics (2015)							
Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016)							
Bachelor' degree (1 major) Physics (2020)							
Bachelor' degree (1 major) Mathematical Physics (2020)							
exchange program Physics (2023)							
		ree (1 major) Mathemat	ical Physics (2024)				
	with 1 ma	jor Mathematical Physics		generated 30-Mär-2024 • ex	-	page 106 / 160	
(2024)			ta record Bachelo	r (180 ECTS) Mathematische	Physik - 2024		

Module title				Abbreviation			
Quantum Field Theory I				11-QFT1B-202-m01			
Module coordinator			Module offered by				
Managing Director o and Astrophysics	f the Institute of Th	Faculty of Physics a	nd Astronomy				
ECTS Method of g	rading	Only after succ. com	pl. of module(s)				
8 numerical gr	rade						
Duration Modu	ıle level	Other prerequisites					
1 semester gradu	ıate						
Contents							
 Lagrange formalis Field quantisation Asymptotic states Gauge principle and Perturbation theory Feynman rules. Quantum elektrood 	 Symmetries. Lagrange formalism for fields. Field quantisation. Asymptotic states, scattering theory and S-matrix Gauge principle and interaction. Perturbation theory. Feynman rules. Quantum elektrodynamical processees in Born approximation. Radiative corrections (optional) 						
Intended learning ou	•						
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 under- standing of radiative corrections and renormalisation.							
V (4) + R (2) Module taught in: Ge	erman or English						
Method of assessme module is creditable for bo		ge — if other than German, e	examination offered — if no	t every semester, information on whether			
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: German and/or English Assessment offered: In the semester in which the course is offered and in the subsequent semester							
Allocation of places							
Additional information							
Workload							
240 h							
Teaching cycle	Teaching cycle						

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

Module appears in

Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title Abbreviation						
Comput	tationa	l Physics			11-CP-152-m01	
Module	coord	inator		Module offered by		
Managi and Ast		ector of the Institute of T sics	heoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6		rical grade		• • • •		
Duratio		Module level	Other prerequisites			
1 semes	ster	undergraduate				
Conten	ts					
• n • si • g • ra						
Intende	ed leari	ning outcomes				
They ha	ive kno	nave knowledge of two r wledge of numerical sta ysical problems, e.g. alg	indard methods and a	are able to apply com	puter-assisted proc	
Courses	5 (type, n	umber of weekly contact hours,	language — if other than Ge	rman)		
V (3) + I Module		t in: German or English				
Method	l of ass	essment (type, scope, langu	age — if other than German,	examination offered — if no	t every semester, informati	ion on whether
		le for bonus)				
or oral e pages) If a writ stead ta of asses nation o Langua	examin or pres ten exa ake the ssmen date at ment o ge of a	nation (approx. 90 to 120 ation in groups (groups entation/talk (approx. 3 amination was chosen a form of an oral examina t is changed, the lecture the latest. ffered: Once a year, win ssessment: German and	of 2, approx. 30 minu 30 minutes). 5 method of assessm ation of one candidate r must inform student ter semester	ites per candidate) o ent, this may be chai e each or an oral exa	r project report (app nged and assessmer mination in groups.	rox. 8 to 10 nt may in- If the method
Allocati	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h			-			
Teachir	ıg cycl	e	_			
Referre	d to in	LPO I (examination regulation	ns for teaching-degree progra	ammes)		
Module	appea	in				
	-	ree (1 major) Physics (2c ree (1 major) Mathemati	-			
Bachelor's v (2024)	with 1 maj	or Mathematical Physics	-	generated 30-Mär-2024 • exa r (180 ECTS) Mathematische I	-	page 109 / 160

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major, 1 minor) Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title Abbreviation						
Statist	ics, Dat	a Analysis and Compu	ter Physics		11-SDC-152-m01	
Module	e coord	inator		Module offered by		
Manag	ing Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	nd Astronomy	
ECTS	<u> </u>	od of grading	Only after succ. con		,	
	1	rical grade				
4		Module level				
Duratio			Other prerequisites			
1 seme	1 semester graduate					
Conten	Contents					
Statisti	ics, dat	a analysis and comput	er physics.			
Intend	ed lear	ning outcomes				
The stu Physics		nave specific and adva	nced knowledge in the	field of statistics, da	ata analysis and Com	ıputational
Course	S (type, r	umber of weekly contact hour	s, language — if other than Ge	rman)		
V (2) +		,	<u> </u>			
		t in: German or English				
Metho	d of ass		guage — if other than German,	examination offered — if no	t every semester, informati	ion on whether
or oral pages) If a writ stead t of asse nation Assess	examin or pres tten exa cake the essmen date at sment o	ation in groups (group eentation/talk (approx. amination was chosen form of an oral examin	as method of assessmenation of one candidate rer must inform student nter semester	ites per candidate) o ent, this may be char e each or an oral exar	r project report (app nged and assessmer mination in groups.	rox. 8 to 10 nt may in- If the method
			Id/of English			
Allocat	tion of p	Diaces				
Additio	onal inf	ormation				
Worklo	ad					
120 h						
	ng cycl	۹				
reaction	<u>15 cyc</u>					
	1					
Referre	ed to in	LPO I (examination regulati	ons for teaching-degree progra	immes)		
Module	e appea	irs in				
	-	ree (1 major) Physics (2	-			
	-	-	cture Technology (2015))		
	-	ree (1 major) Mathema				
	-	ree (1 major) Mathema				
	-	ree (1 major) Physics (2 ree (1 major) Nanostru	2020) cture Technology (2020)		
	-	ree (1 major) Nathema		<i>י</i> י		
	-	ree (1 major) Mathema ree (1 major) Quantum	•			
	-	gram Physics (2023)	10010gy (2021)			
		or Mathematical Physics	JMU Würzburg •	generated 30-Mär-2024 • exa	am. reg. da-	page 111 / 160
(2024)		,	-	r (180 ECTS) Mathematische I	-	



Bachelor' degree (1 major) Mathematical Physics (2024)

Module	Module title Abbreviation					
Astroph	nysics				11-AP-152-m01	
Module	coord	inator		Module offered by		
		ector of the Institute of T	Theoretical Physics	Faculty of Physics a	nd Astronomy	
and Ast			Γ			
ECTS		od of grading	Only after succ. con	npl. of module(s)		
6		rical grade				
Duratio						
	1 semester undergraduate					
Conten						
		onomy, coordinates and d detectors, stellar stru				
		clouds, structure of the				
		arge-scale structures, c		· •		
Intende	ed learı	ning outcomes				
		are familiar with the mo				
		rvations and evaluation				
laxies.	ey are	familiar with the physic	s and development of	the main astrophysic	cal objects such as s	stars and ga-
	S (type, n	umber of weekly contact hours	, language — if other than Ge	rman)		
V (2) + I	R (2)					
Module	taugh	t in: German or English				
		s essment (type, scope, langu le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informat	ion on whether
		nination (approx. 90 to	120 minutos) or b) or	al avamination of an	candidate each (ar	nrox ao mi
		al examination in group				
prox. 8	to 10 p	ages) or e) presentation	n/talk (approx. 30 min	utes).		
		amination was chosen a			-	· · ·
		e form of an oral examin t is changed, the lecture				
		the latest.				
Langua	ge of a	ssessment: German an	d/or English			
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachir	ıg cycl	8				
		LPO I (examination regulation	ns for teaching-degree progra	ammes)		
§ 22 N						
§ 22 N § 22 N						
Module		urs in				
		ree (1 major) Physics (2	015)			
		ree (1 major) Mathemat				
	with 1 maj	or Mathematical Physics		generated 30-Mär-2024 • exa	-	page 113 / 160
(2024)			ta record Bachelo	r (180 ECTS) Mathematische I	Physik - 2024	

UNIVERSITÄT WÜRZBURG

Bachelor' degree (1 major) Aerospace Computer Science (2015) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) First state examination for the teaching degree Grundschule Physics (2015) First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2015) First state examination for the teaching degree Realschule Physics (2015) First state examination for the teaching degree Gymnasium Physics (2015) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2015) First state examination for the teaching degree Mittelschule Physics (2015) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Master's degree (1 major) Nanostructure Technology (2016) Bachelor' degree (1 major) Aerospace Computer Science (2017) First state examination for the teaching degree Grundschule Physics (2018) First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2018) First state examination for the teaching degree Realschule Physics (2018) First state examination for the teaching degree Gymnasium Physics (2018) First state examination for the teaching degree Mittelschule Physics (2018) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2018) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2018) Master's degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) Bachelor' degree (1 major) Aerospace Computer Science (2020) First state examination for the teaching degree Grundschule Didactics in Physics (Primary School) (2020) First state examination for the teaching degree Grundschule Physics (2020) First state examination for the teaching degree Gymnasium Physics (2020) First state examination for the teaching degree Realschule Physics (2020) First state examination for the teaching degree Sonderpädagogik Didactics in Physics (Middle School) (2020) First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2020) First state examination for the teaching degree Mittelschule Physics (2020) Master's degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module	e title				Abbreviation	
Particle	e Physi	cs (Standard Model)			11-TPS-152-m01	
Module	a coord	inator		Module offered by		
		ectors of the Institute o	f Applied Physics and	Faculty of Physics a	nd Astronomy	
		f Theoretical Physics a			ind Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
8	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	1 semester undergraduate					
Conten	ts					
		scription of the Standa				
parity V		ymmetry breaking thro n	ugn the Higgs mechani	Sm		
Bhabha	a scatte	ering				
		and forward / reverse a	symmetry			
		ion and decay setup and results of ke	y experiments to test th	he Standard Model a	nd for determining	its parame-
ters			, , , , , , , , , , , , , , , , , , ,		0	-
		Higgs boson				
		ning outcomes				
		know the theoretical fu t have established and				
		sults in the framework of				
Course	S (type, r	number of weekly contact hour	s, language — if other than Ge	rman)		
V (4) +	R (2)					
Module	e taugh	t in: German or English				
		sessment (type, scope, lang	uage — if other than German,	examination offered — if no	t every semester, informa	tion on whether
		le for bonus)			lidata angle (anguna	
		nation (approx. 90 to 1: lation in groups (group				
		sentation/talk (approx.				
		amination was chosen				
		e form of an oral examin t is changed, the lectur				
nation	date at	the latest.		·····, ···		0
		ssessment: German an	id/or English			
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
240 h		0	_			
Teachi	ig cycl	e				
 Deferre	d to in		one for tooch in a dealer	ammac)		
Releffe		LPO I (examination regulati	uns for teaching-degree progra	annines)		
 Module	appea	urs in				
 Module		i rs in		generated 30-Mär-2024 • exa		page 115 / 160

Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title Abbreviation				Abbreviation	
Theory	of Rela	tivity			11-RTTB-232-m01
Module	coord	inator		Module offered by	
Managi and Ast	-	ector of the Institute of Th ics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 semes	ster	undergraduate			
Content	ts				
Differen Brief Su Elemen Electroo Field eg Stellar o	Mathematical Foundations Differential forms Brief Summary of the special relativity Elements of differential geometry Electrodynamics as an example of a relativistic gauge theory Field equations of the fundamental structure of general relativity Stellar equilibrium and other astrophysical applications Introduction to cosmology				
Intende	d learn	ning outcomes			
of the fo and the	ormula theory	tion in terms of differenti	al forms. Understand ving both of them as	ling of the formal sim gauge theories. App	ity. Mathematical understanding nilarity between electrodynamics lication of the theory to simple
Courses	5 (type, n	umber of weekly contact hours, la	anguage — if other than Ger	man)	
V (3) + F Module		t in: German or English			
		e essment (type, scope, languag le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
nutes) of prox. 8 If a writ stead ta of asses nation of Langua	or c) or to 10 p ten exa ake the ssment date at ge of a	al examination in groups ages) or e) presentation/ amination was chosen as form of an oral examinat	(groups of 2, approx talk (approx. 30 min method of assessme ion of one candidate must inform student or English	. 30 minutes per can utes). ent, this may be char e each or an oral exar s about this by four v	e candidate each (approx. 30 mi- didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- llowing semester
Allocati	on of p	olaces			
Additio	nal inf	ormation			
Approva	al from	examination committee	required		
Worklo	ad				
180 h					
Teachin	ig cycl	9			
Referre	d to in	LPO I (examination regulations	for teaching-degree progra	mmes)	

Module appears in

Bachelor' degree (1 major) Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2024)



Module Group Current Topics in Mathematical Physics

(ECTS credits)

Modul	e title				Abbreviation
Curren	t Topic	s in Mathematical Physi	cs		11-BXMP5-152-m01
Modul	e coord	inator		Module offered by	I
		f examination committee matical Physics)	e Mathematische	Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
5	nume	rical grade			
Duratio		Module level	Other prerequisites		
1 seme	ester	undergraduate	Approval from exam		equired.
Conter					
	t topics ly abroa		s. Accredited academ	ic achievements, e.g	g. in case of change of university
Intend	ed lear	ning outcomes			
sics of unders subjec	the Bac stand th t-specif	chelor's programme. The	y have knowledge of nethods necessary to e application areas.	a current subdiscipl acquire this knowle	of a module of Mathematical Phy- ine of Mathematical Physics and dge. They are able to classify the
	_		language — Il other than der	IIIdii)	
V (2) +		_			
		Gessment (type, scope, langua le for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on whether
or oral pages) If a wri stead t of asse nation	examir or pres tten exa take the essmen date at	ation in groups (groups entation/talk (approx. 3 amination was chosen a form of an oral examina	of 2, approx. 30 minu o minutes). s method of assessm ation of one candidate r must inform student	tes per candidate) o ent, this may be cha e each or an oral exa	didate each (approx. 30 minutes) or project report (approx. 8 to 10 nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	bad				
150 h					
-	ng cycl	e			
	- /				
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree progra	mmes)	
Modul	e appea	urs in			
		ree (1 major) Mathematio	cal Physics (2015)		
	-				
	Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020)				
Dather		ice (I major) matricinatio	cal Physics (2020)		

Modul	e title				Abbreviation
Curren	t Topic	s in Mathematical Physic	cs		11-BXMP6-152-m01
Modul	e coord	inator		Module offered by	<u> </u>
		f examination committee ematical Physics)	Mathematische	Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
6	1	rical grade			
Duratio		Module level	Other prerequisites		
1 seme	_	undergraduate		ination committee r	equired
Conter					
Curren			s. Accredited academ	ic achievements, e.g	g. in case of change of university
Intend	ed lear	ning outcomes			
sics of unders subjec	the Bac stand th t-specif	chelor's programme. The	y have knowledge of nethods necessary to e application areas.	a current subdiscipl acquire this knowle	of a module of Mathematical Phy- ine of Mathematical Physics and odge. They are able to classify the
V (3) +		lumber of weekly contact hours,			
		accmont (transported by and		in-tion offered if a	
		le for bonus)	age — If other than German,	examination offered — if no	ot every semester, information on whether
or oral pages) If a wri stead t of asse nation	examir or pres tten exa take the essmen date at	aation in groups (groups sentation/talk (approx. 3 amination was chosen as e form of an oral examina	of 2, approx. 30 minu o minutes). 5 method of assessmo tion of one candidate r must inform student	ites per candidate) o ent, this may be cha e each or an oral exa	didate each (approx. 30 minutes) or project report (approx. 8 to 10 nged and assessment may in- mination in groups. If the methoo weeks prior to the original exami
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	bad				
180 h					
	ng cycl	e			
Referre	ed to in	LPOI (examination regulation	s for teaching-degree progra	ummes)	
			00		
Modul	e appea	ars in			
		ree (1 major) Mathematic	cal Physics (2015)		
	-	ree (1 major) Mathematic	,		
	-	ree (1 major) Mathematic			
		ree (1 major) Mathematic			

Modul	e title				Abbreviation
Curren	t Topic	s in Mathematical Physic	CS		11-BXMP8-152-m01
Modul	e coord	inator		Module offered by	<u> </u>
		f examination committee ematical Physics)	Mathematische	Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
8	1	rical grade			
Duratio		Module level	Other prerequisites		
1 seme		undergraduate		ination committee r	equired
Conter		undergraduite			
Curren		-	s. Accredited academ	ic achievements, e.g	g. in case of change of university
Intend	ed lear	ning outcomes			
sics of unders subjec	the Bac stand th t-specif	chelor's programme. The	y have knowledge of nethods necessary to e application areas.	a current subdiscipl acquire this knowle	of a module of Mathematical Phy ine of Mathematical Physics and dge. They are able to classify the
V (4) +		initial of weekly collact hours,	unguage – n other tildh Gel		
		_			
		Sessment (type, scope, langua Ile for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on whether
or oral pages) If a wri stead t of asse nation	examir or pres tten exa take the essmen date at	aation in groups (groups sentation/talk (approx. 3 amination was chosen as form of an oral examina	of 2, approx. 30 minu o minutes). 5 method of assessmo tion of one candidate r must inform student	tes per candidate) o ent, this may be cha e each or an oral exa	didate each (approx. 30 minutes) or project report (approx. 8 to 10 nged and assessment may in- mination in groups. If the methoo weeks prior to the original exami
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	bad				
240 h					
	ng cycl	e	-		
Referre	ed to in	LPOI (examination regulation	s for teaching-degree progra	mmes)	
Modul	e appea	ars in			
		ree (1 major) Mathematic	al Physics (2015)		
	-	ree (1 major) Mathematic	,		
	-	ree (1 major) Mathematic	, , ,		
		ree (1 major) Mathematic			



Key Skills Area (20 ECTS credits)



General Key Skills

(5 ECTS credits)

In addition to the modules listed below, students may also take modules offered by JMU as part of the pool of general transferable skills (ASQ).



General Key Skills (subject-specific)

(ECTS credits)

Module	e title				Abbreviation		
Exercis	e tutor	or proof-reading in Ma	athematics		10-M-TuKo-152-mo	1	
Module	e coord	inator		Module offered by	L		
Dean o	f Studi	es Mathematik (Mathe	matics)	Institute of Mathem	atics		
ECTS	1	od of grading	Only after succ. con				
5	1	successfully completed					
Duratio		Module level	Other prerequisites				
1 semester undergraduate							
Conten		undergradate					
		ding homowork for on	e of the basic courses i	n tha Bachalar's or t	oaching dogroo prov	Trammos un-	
		-	turer or exercise superv		eaching degree pros	siannies un-	
Intend	ed lear	ning outcomes					
The stu	dent is	able to support the ac	quisition of mathemati	cal skills and knowle	edge. He/She helps	to identify	
			cises and to find possi			-	
Course	S (type, r	umber of weekly contact hour	s, language — if other than Ger	man)			
T (o)							
Metho	d of ass	essment (type, scope, lang	guage — if other than German, o	examination offered — if no	t every semester, informat	ion on whether	
		le for bonus)					
		-	correcting work by supe	rvising lecturers or e	exercise supervisors	(1 to 2 tea-	
		approx. 5 pieces of co	rrecting work)				
Allocat	ion of p	olaces					
Additio	onal inf	ormation					
Please	direct a	application to teaching	coordinator Mathemat	ics, he/she will sele	ct participants.		
Worklo	ad						
150 h							
Teachi	ng cycl	e					
Referre	ed to in	LPO I (examination regulati	ons for teaching-degree progra	mmes)			
§ 22		•		-			
Module		ins in					
		ree (1 major) Mathema	tics (2015)				
	-	ree (1 major) Economa					
		ree (1 major) Mathema					
Bachel	or' deg	ree (1 major) Computat	ional Mathematics (20	15)			
First sta	ate exa	mination for the teachi	ng degree Gymnasium	Mathematics (2015)			
Bachel	or' deg	ree (1 major) Mathema	tical Physics (2016)				
	-	ree (1 major) Economa					
			ng degree Gymnasium	Mathematics (2019)			
	-	ree (1 major) Mathema	•				
	-	ree (1 major) Economa					
Bachelor' degree (1 major) Economathematics (2022)							
	or' dog	ree (1 maior) Mathema	tical Data Science (202	2)			
Bachel	-		exchange program Mathematics (2023)				
Bachel exchan	ige prog	gram Mathematics (20		Mathematics			
Bachel exchan First sta	ige prog ate exa	gram Mathematics (20 mination for the teachi	ng degree Gymnasium	Mathematics (2023)			
Bachel exchan First sta Bachel	ge prog ate exa or' deg	gram Mathematics (20	ng degree Gymnasium tics (2023)	Mathematics (2023)		page 126 / 160	

Bachelor' degree (1 major) Economathematics (2023) Bachelor' degree (1 major) Mathematical Physics (2024) Bachelor' degree (1 major) Economathematics (2024)

Module	e title			-	Abbreviation	
E-Learn	ning an	d Blended Learning Ma	thematics 1		10-M-VHB1-152-mo	1
Module	e coord	inator		Module offered by	<u> </u>	
		es Mathematik (Mather	natics)	Institute of Mathem	natics	
ECTS	1	od of grading	Only after succ. con			
2		successfully completed				
Duratio		Module level Other prerequisites				
1 seme	ster	undergraduate				
Contents						
		iliar with and reflecting	 techniques in e-learni	ing and blended lear	ming in mathematic	c
		ning outcomes			ining in mathematic	
		-			· · · · · · · · · · · · · · · · · · ·	
		able to employ basic n			g in mathematics-	
	S (type, r	umber of weekly contact hours	s, language — if other than Ger	rman)		
Ü (2)	1			(
		Learning, mostly Virtue	· · · · · · · · · · · · · · · · · · ·			
		essment (type, scope, lang	uage — if other than German,	examination offered — if no	ot every semester, informat	ion on whether
	-	le for bonus)				
		based, 15 to 20 hours) ffered: Once a year, wir	nter semester			
Allocat						
Allocal		Jaces				
•••						
Additio	nat inf	ormation				
Worklo	ad					
60 h						
Teachi	ng cycl	e				
Referre	d to in	LPO I (examination regulation	ons for teaching-degree progra	immes)		
Module	e appea	irs in				
		ree (1 major) Mathemat	ics (2015)			
	0	ree (1 major) Economat				
Bachel	or' deg	ree (1 major) Mathemat	ical Physics (2015)			
	-	ree (1 major) Computati		15)		
Bachel	or' deg	ree (1 major) Mathemat	ical Physics (2016)			
	-	ree (1 major) Economat				
		es (Bachelor) Mathemat				
		es (Bachelor) Orientieru	-			
	-	ree (1 major) Mathemat	-			
	-	ree (1 major) Economat				
		ree (1 major) Economat		-)		
	-	ree (1 major) Mathemat		2)		
		gram Mathematics (202	-			
	-	ree (1 major) Mathemat	-			
	-	ree (1 major) Economat ree (1 major) Mathemat	-			
		-		concreted as Maria	am rag de	
UNAL THEIDE C	with 1 ma	or Mathematical Physics		generated 30-Mär-2024 • ex r (180 ECTS) Mathematische	-	page 128 / 160



Bachelor' degree (1 major) Economathematics (2024)

Module	title				Abbreviation	
E-Learn	ing an	d Blended Learning Ma	thematics 2		10-M-VHB2-152-mo	1
Module	coord	inator		Module offered by	<u> </u>	
		es Mathematik (Mathen	natics)	Institute of Mathem	natics	
		•			latics	
ECTS		od of grading	Only after succ. com	ipi. of module(s)		
2		successfully completed				
Duratio	n	Module level	Other prerequisites			
1 seme	1 semester undergraduate					
Conten	ts					
Becomi	ing fam	iliar with and reflecting	techniques in e-learni	ng and blended lear	ming in mathematics	5.
Intende	ed lear	ning outcomes				
		able to employ advanc	ed methods of e-learn	ing and blended lea	rning in mathematic	s-
		umber of weekly contact hours				-
Ü (2)		amper of weekly contact hours		many		
• •	type: e	Learning, mostly Virtue	lle Hochschule Bavern	(vhb)		
		essment (type, scope, langu			tovoni comoctor informati	ion on whether
		le for bonus)	iage — ii other than German, (zzanimation onered — if ho	n every semester, mormat	ion on whether
		based, 15 to 20 hours)				
		ffered: Once a year, sur	nmer semester			
Allocat						
Additio	nalinf	ormation				
Additio	natini	ormation				
Worklo	ad					
60 h			_			
Teachir	ıg cycl	е				
Referre	d to in	LPO I (examination regulation	ns for teaching-degree progra	mmes)		
Module	annea	urs in				
		ree (1 major) Mathemat	ice (2015)			
		ree (1 major) Economatl				
		ree (1 major) Mathemat				
	-	ree (1 major) Computati	• •	15)		
	-	ree (1 major) Mathemat				
	-	ree (1 major) Economatl				
		es (Bachelor) Mathemat	-			
		es (Bachelor) Orientieru	•			
	-	ree (1 major) Mathemat	•			
	-	ree (1 major) Economatl				
	-	ree (1 major) Economatl ree (1 major) Mathemat		2)		
	-	gram Mathematics (202		<i>~</i>)		
		ree (1 major) Mathemat				
	-	ree (1 major) Economatl	-			
	-	ree (1 major) Mathemat	_			
		or Mathematical Physics		generated 30-Mär-2024 • ex	am. reg. da-	page 130 / 160
(2024)				r (180 ECTS) Mathematische		



Bachelor' degree (1 major) Economathematics (2024)

Modul	e title				Abbreviation
MINT P	repara	tory Course Mathematica	al Methods of Physic	:s	11-P-VKM-202-m01
Modul	e coord	inator		Module offered by	·
	ing Dire trophys	ector of the Institute of Th sics	neoretical Physics	Faculty of Physics a	and Astronomy
ECTS Method of grading Only after succ. compl. of module(s)					
3	1	successfully completed		•	
Duratio					
1 seme		undergraduate			
Conter		undergraduate	<u> </u>		
introdu 1. Basi quanti	uction a c geom ties, 5.	nd preparation for the m etry and algebra, 2. diffe coordinate systems, 6. co	odules of experimen rential calculus and s	tal and theoretical p	dge from school, especially as ar hysics. culus, 4. vectors – directional
		ning outcomes	-		
		n command of knowledg successful start into the			ls in elementary calculus as re- bhysics.
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ge	erman)	
V (1) + Module	• •	t in: German or English			
		Sessment (type, scope, langua le for bonus)	ıge — if other than German,	examination offered — if no	ot every semester, information on whether
a) exer	cises (s			rox. 6 exercise sheets	s) or b) talk (approx. 15 minutes)
	tion of p	·			
Additio	nal inf	ormation	-		
Auunt			-		
Worklo	ad				
90 h					
*	ng cycl	e			
		e: every year, winter sem	ester		
	/	LPOI (examination regulation		ammes)	
	Nr. 1 h) Nr. 2 f)		0 Piv3.		
	e appea	ars in			
		ree (1 major) Physics (20	20)		
Bachel	or' deg	ree (1 major) Nanostructu	ure Technology (2020	o)	
		ree (1 major) Mathematic			
		gree (1 major, 1 minor) Pl	-	o Didactica in Dhusis	c (Drimony School) (cooo)
		mination for the teaching		•	s (Primary School) (2020)
		mination for the teaching			
		mination for the teaching		•	
				•	hysics (Middle School) (2020)
		ior Mathematical Physics		● generated 30-Mär-2024 ● ex	xam. reg. da- page 132 / 160

Bachelor's with 1 major Mathematical Physics	JMU Würzburg • generated 30-Mär-2024 • exam. reg. da-	page 132 / 160
(2024)	ta record Bachelor (180 ECTS) Mathematische Physik - 2024	



First state examination for the teaching degree Mittelschule Didactics in Physics (Middle School) (2020) First state examination for the teaching degree Mittelschule Physics (2020) Bachelor' degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Mathematical Physics (2024)



Subject-specific Key Skills

(15 ECTS credits)



Compulsory Courses

(9 ECTS credits)

Module	e title		Abbreviation				
Basic Notions and Methods of Mathematical Reasoning					10-M-GBM-152-mo	L	
Module coordinator			Module offered by				
Dean of Studies Mathematik (Mathematics)			Institute of Mathematics				
ECTS	Metho	od of grading	Only after succ. con	mpl. of module(s)			
2	1	successfully completed					
	Duration Module level Other prerequisites						
	1 semester undergraduate						
Conten							
		o the basic notions and	 proof techniques in m	athematics, approa	ch to sets formal los	ric and mans	
		ning outcomes				sic and maps	
		-			auticite o fourth o fourth		
		ets acquainted with the degree study programn		ques which are prere	quisites for the furth	ier courses in	
		umber of weekly contact hours,		rman)			
V (1) +		lumber of weekly contact hours,					
.,		account (· · · · · · · · · · · ·			
		sessment (type, scope, langu le for bonus)	age — If other than German,	examination offered — if no	ot every semester, informat	ion on whether	
		15 pages)					
		ssessment: German and	l/or English				
Allocat	-		<u> </u>				
Additio	nal inf	ormation					
		ormation on module dur		ior to the beginning	of the lecture period	1	
Worklo					or the tecture period	•	
	au						
60 h			_				
Teachi	ng cycl	6					
			_				
		LPO I (examination regulation	ns for teaching-degree progra	ammes)			
§ 22							
§ 22		•					
Module							
		ree (1 major) Mathemati					
Bachelor' degree (1 major) Economathematics (2015)							
Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015)							
First state examination for the teaching degree Grundschule Mathematics (2015)							
First state examination for the teaching degree Realschule Mathematics (2015)							
First state examination for the teaching degree Mittelschule Mathematics (2015)							
Bachelor' degree (1 major) Mathematical Physics (2016)							
Bachelor' degree (1 major) Economathematics (2017)							
Module studies (Bachelor) Mathematics (2019)							
Module studies (Bachelor) Orientierungsstudien (2020)							
	ate exa	mination for the teachin	g degree Mittelschule	Mathematics (2020	(Prüfungsordnungs	version	
2015)) Dachal	-اراسم						
Bachelor' degree (1 major) Mathematical Physics (2020)							
Rachol	Bachelor' degree (1 major) Economathematics (2021) Bachelor's with 1 major Mathematical Physics JMU Würzburg • generated 30-Mär-2024 • exam. reg. da- page 136 / 160						
	-	-					

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Bachelor' degree (1 major) Economathematics (2022) Bachelor' degree (1 major) Mathematical Data Science (2022) exchange program Mathematics (2023) Bachelor' degree (1 major) Mathematics (2023) Bachelor' degree (1 major) Economathematics (2023) Bachelor' degree (1 major) Mathematical Physics (2024) Bachelor' degree (1 major) Economathematics (2024)

Module	e title				Abbreviation		
Reason	ning an	d Writing in Mathemati	cs		10-M-ASM-152-m01		
Module	a coord	inator		Module offered by			
Module coordinator Dean of Studies Mathematik (Mathematics)			natics)	Institute of Mathematics			
			E .				
2	<u> </u>	successfully completed	Only after succ. compl. of module(s)				
 Duratio		Module level	Other prerequisites				
Conten	1 semester undergraduate						
Introdu	iction to ical wri				in mathematics as well as approach to axiomatic and		
Intende	ed learı	ning outcomes					
form ea oral for	asy mat m.	hematical arguments in	ndependently and pres	sent them adequately	nematics. He/She is able to y and reasonably in written		
		umber of weekly contact hours	, language — if other than Gei	rman)			
V (1) + I							
			uage — if other than German,	examination offered — if no	t every semester, information on w	/hether	
		le for bonus)					
		20 pages) ssessment: German an	d/or English				
Allocat							
Allocal		haces					
Additio	nal inf	ormation					
	nat mit						
Worklo							
60 h							
Teachi		0					
reacini	ig cycl	5					
Poforro	d to in	LPO I (examination regulation					
Neielle			ins for teaching-degree progra	ininies)			
Module		urs in					
		ree (1 major) Mathemat	ics (2015)				
	-						
Bachelor' degree (1 major) Economathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015)							
Bachelor' degree (1 major) Computational Mathematics (2015)							
Bachelor' degree (1 major) Mathematical Physics (2016)							
Bachelor' degree (1 major) Economathematics (2017)							
Module studies (Bachelor) Mathematics (2019)							
Module studies (Bachelor) Orientierungsstudien (2020) Bachelor' degree (1 major) Mathematical Physics (2020)							
	-		-				
	-	ree (1 major) Economat ree (1 major) Economat					
	-	ree (1 major) Economati ree (1 major) Mathemat		2)			
		gram Mathematics (202		<i>-</i> ,			
		or Mathematical Physics		generated 30-Mär-2024 • ex	am. reg. da-	138 / 160	
(2024)		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		r (180 ECTS) Mathematische		5-7-00	

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Bachelor' degree (1 major) Mathematics (2023) Bachelor' degree (1 major) Economathematics (2023) Bachelor' degree (1 major) Mathematical Physics (2024) Bachelor' degree (1 major) Economathematics (2024)

Module	title				Abbreviation		
Seminar Mathematical Physics 11-SMP-162-mo1							
Module	e coord	inator		Module offered by			
chairperson of examination committee Mathematische Physik (Mathematical Physics)							
ECTS				npl. of module(s)			
5	(not) s	successfully completed					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts						
A selec	ted top	oic of Mathematical Physi	CS.				
Intende	ed lear	ning outcomes					
	a giver	n topic on the basis of lite			olves the development and divi- ell as the ability to actively partici-		
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)			
S (2) Module	taugh	t in: German or English					
		sessment (type, scope, langua ıle for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether		
		o minutes) ssessment: German and,	/or English				
Allocat	ion of _l	olaces					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teachir	ıg cycl	e					
Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	immes)			
Module	e appea	ars in					
Bachelo	Module appears in Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2024)						



Subject-specific Key Skills, Compulsory Electives

(6 ECTS credits)

Supplementary Seminar Mathematics 10-M-SEM2-152-m01 Module coordinator Module offered by Dean of Studies Mathematik (Mathematics) Institute of Mathematics ECTS Method of grading Only after succ. compl. of module(s) 4 (not) successfully completed Duration Module level Other prerequisites 1 semester undergraduate Contents A selected topic in mathematics. Institute of Mathematics here 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 active ly in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than Geman) S (a) Method of assessment (type, scope, language – if other than Geman, examination offered – if not every semester, information on whether module is creditable for bouso) Ianguage of assessment. German and/or English Allgradge assessment. German and/or English Allgradge assessment. German and/or English Allgradge of assessment (spece (nangor) Mathematics (2015) Bachelor degree (nangor) Mathematics (2015) Bachelor degree (nangor) Mathematics (2015) Bachelor degree (nangor) Mathematics (2015) <th>Module</th> <th>title</th> <th></th> <th></th> <th>Abbreviation</th>	Module	title			Abbreviation			
Dean of Studies Mathematik (Mathematics) Institute of Mathematics ECTS Method f grading Only after succ. compl. of module(s) Comparing the mathematik (Mathematics) Only after succ. compl. of module(s) Quration Module level Other prerequisites Duration Module level Other prerequisites Isemester undergraduate						10-M-SEM2-152-m01		
ECTS Method of grading Only after succ. compl. of module(s) 4 (not) successfully completed Duration Module level Other prerequisites 1 semester undergraduate Contents A selected topic in mathematics. Intended learning outcomes The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) Language of assessment: German and/or English Additional information Vorkload 120 h Referred to in LPO I (examination regulations for teaching-degree programmes)	Module coordinator Module offe							
4 (not) successfully completed Duration Module level Other prerequisites 1 semester undergraduate Contents A selected topic in mathematics. Intende learning outcomes The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate active ly in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) talk (6 to 120 minutes) Language of assessment: German and/or English Allocation of places Additional information Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) <td colspan="3">Dean of Studies Mathematik (Mathematics)</td> <td>atics)</td> <td colspan="3">Institute of Mathematics</td>	Dean of Studies Mathematik (Mathematics)			atics)	Institute of Mathematics			
4 (not) successfully completed Duration Module level Other prerequisites 1 semester undergraduate Contents A selected topic in mathematics. Intende learning outcomes The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate active ly in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) talk (60 to 120 minutes) Language of assessment: German and/or English Atlocation of places Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1	ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)			
Duration Module level Other prerequisites 1 semester undergraduate Contents A selected topic in mathematics. Intende learning outcomes The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate actively in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) talk (60 to 120 minutes) Language of assessment: German and/or English Allocation of places Additional information Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015)	4				• • • •			
1 semester undergraduate				Other prerequisites				
Contents A selected topic in mathematics. Intended learning outcomes The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate active- ly in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) Language of assessment: German and/or English Allocation of places Morkload L20 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Data Science (2022) Bachelor' degree (1 major) Mathematical Data Science (2022) Bachelor' degree (1 major) Mathematical Data Science (2022) Bachelor' degree (1 major) Mathematical Capis (2015) Bachelor' degree (1 major) Mathematical Capis (2020) Bachelor' degree (1	1 seme	ster	undergraduate					
A selected topic in mathematics. Intended learning outcomes The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate active- ly in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) talk (60 to 120 minutes) Language of assessment: German and/or English Allocation of places Additional information Workload 120 h Teaching cycle Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Phy	Conten	ts	0					
Intended learning outcomes The student gains first experience with independent scientific work. He/She masters elaboration and structuring of a given topic using selected literature, and prepares a talk on the subject. He/She is able to participate active- ly in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) talk (60 to 120 minutes) Language of assessment: German and/or English Allocation of places Motkload 120 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 m			bic in mathematics.					
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 active- ly in a scientific discussion. Courses (type, number of weekly contact hours, language – if other than German) S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for borus) talk (60 to 120 minutes) Language of assessment: German and/or English Allocation of places Additional information Workload 120 h Teaching cycle Referred to in LPO I (examination for teaching-degree programmes) Module appears in Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1								
S (2) Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) talk (60 to 120 minutes) Language of assessment: German and/or English Allocation of places Additional information Workload 120 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Data Science (2022) Bachelor' degree (1 major) Mathematics (2023)	of a giv	en topi	ic using selected literatur	•	-			
Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) talk (60 to 120 minutes) Language of assessment: German and/or English Allocation of places Additional information Workload 120 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Data Science (2022) Bachelor' degree (1 major) Mathematical Data Science (2022) Bachelor' degree (1 major) Mathematical Data Science (2022)	Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)			
module is creditable for bonus) talk (60 to 120 minutes) Language of assessment: German and/or English Allocation of places Additional information Workload 120 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020)	S (2)							
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Bachelor' degree (1 major) Mathematical Data Science (2022) Bachelor' degree (1 major) Mathematics (2023)								
Bachelor' degree (1 major) Mathematics (2023)		-		•	2)			

Semina	e title				Abbreviation	
Seminar Experimental/Theoretical Physics					11-HS-152-m01	
Module coordinator				Module offered by		
		ectors of the Institute o f Theoretical Physics a		Faculty of Physics a	and Astronomy	
ECTS	1	od of grading	Only after succ. cor	npl. of module(s)		
5	numerical grade					
Duratio		Module level	Other prerequisites	•		
1 seme		undergraduate		isite to assessment:	regular attendance	(minimum
Conten	Its		U			
Current	t issues	of Theoretical/Experir	mental Physics.			
		ning outcomes				
to inde	pender	have advanced knowle htly acquire this knowle number of weekly contact hour	edge and to summarise	e it in an oral present		. They are able
S (2)		t in: German or English		rman)		
		sessment (type, scope, lang le for bonus)	guage — if other than German,	examination offered — if no	ot every semester, informa	ation on whether
talk wit	th discu	ussion (30 to 45 minute	es)			
Allocat	ion of _l	olaces				
		ormation				
Registr this wil 3 Sente find tha gistrati ly regis sessme	ation: I Il be co ence 4 at the s on for a ter for ent was	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the	on to assessment pu ulations). If the mod hission to assessmen hat meet the respect r for an assessment e respective assessm	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme	ation: I ll be co ence 4 at the s on for a ster for ent was ent to w	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the	on to assessment pu ulations). If the mod hission to assessmen hat meet the respect r for an assessment e respective assessm	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo	ation: I ll be co ence 4 at the s on for a ster for ent was ent to w	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the	on to assessment pu ulations). If the mod hission to assessmen hat meet the respect r for an assessment e respective assessm	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h	ation: I Il be co ence 4 / at the s on for a ster for a ent ro w ent to w	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will which he/she has not b	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the	on to assessment pu ulations). If the mod hission to assessmen hat meet the respect r for an assessment e respective assessm	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo	ation: I Il be co ence 4 / at the s on for a ster for a ent ro w ent to w	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will which he/she has not b	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the	on to assessment pu ulations). If the mod hission to assessmen hat meet the respect r for an assessment e respective assessm	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachi	ation: I Il be co ence 4 <i>i</i> at the s on for a ster for a ent was ent to w pad	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will which he/she has not b	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachi	ation: I Il be co ence 4 <i>i</i> at the s on for a ster for a ent was ent to w pad	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will which he/she has not b	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachin Referre	ation: I Il be co ence 4 <i>i</i> at the s on for a ster for a ent was ent to w bad	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will which he/she has not b e LPO I (examination regulati	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme 150 h Teachin Referre Module	ation: I Il be co ence 4 a at the s on for a ster for a ent was ent to w bad ng cycl ed to in	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will hich he/she has not b e LPOI (examination regulati	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachin Referre Bachel	ation: I Il be co ence 4 / at the s on for a ster for a ent was ent to w pad ng cycl ed to in e appea or' deg	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will which he/she has not b e LPO I (examination regulati trs in ree (1 major) Physics (2	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachin Referre Bachel Bachel	ation: I Il be co ence 4 / at the s on for a ster for a ent was ent to w bad ng cycl ed to in e appea or' deg or's deg	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will which he/she has not b e LPO I (examination regulation ree (1 major) Physics (2 gree (1 major, 1 minor)	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad ons for teaching-degree progra 2015) Physics (Minor, 2015)	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachin Referre Bachel Bachel Bachel	ation: I Il be co ence 4 <i>i</i> at the s on for a ster for ent was ent to w bad ng cycl ed to in e appea or' deg or's de or' deg	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will /hich he/she has not b e LPO I (examination regulati ars in ree (1 major) Physics (2 gree (1 major, 1 minor) ree (1 major) Physics (2	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad ons for teaching-degree progra 2015) Physics (Minor, 2015) 2020)	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachin Referre Bachel Bachel Bachel Bachel	ation: I Il be co ence 4 a at the s on for a ent was ent to w bad ng cycl ed to in e appea or' deg or' deg or' deg or' deg	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will /hich he/she has not b e LPOI (examination regulati ree (1 major) Physics (2 gree (1 major) Physics (2 ree (1 major) Mathema	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad ons for teaching-degree progra 2015) Physics (Minor, 2015) 2020) tical Physics (2020)	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachin Referre Bachel Bachel Bachel Bachel Bachel	ation: I Il be co ence 4 a at the s on for a ter for ent was ent to w ad ad ad ad ad ad ad ad ad ad ad ad ad	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer not put into effect will /hich he/she has not b e LPO I (examination regulati ars in ree (1 major) Physics (2 gree (1 major, 1 minor) ree (1 major) Physics (2	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th nts who did not registe not be admitted to the een admitted, the grad ons for teaching-degree progra 2015) Physics (Minor, 2015) 2020) tical Physics (2020)	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
Registr this wil 3 Sente find tha gistrati ly regis sessme sessme Worklo 150 h Teachin Referre Bachel Bachel Bachel Bachel Bachel Bachel Bachel Bachel	ation: I Il be co ence 4 a at the s on for a ster for a ent was ent to w bad ng cycl ad to in e appea or' deg or' deg or' deg or's de ge prog	f a student registers fo nsidered a declaration ASPO (general academ tudent has obtained th assessment into effect. an assessment. Studer a not put into effect will which he/she has not b e LPO I (examination regulati ars in ree (1 major) Physics (2 gree (1 major) Physics (2 ree (1 major) Mathema gree (1 major, 1 minor)	of will to seek admissi ic and examination reg ne qualification for adm . Only those students th the symbol of the register and be admitted to the een admitted, the grad ons for teaching-degree progra- 2015) Physics (Minor, 2015) 2020) tical Physics (2020) Physics (Minor, 2020)	on to assessment pu gulations). If the mod hission to assessmen hat meet the respect r for an assessment of respective assessm le achieved in this as	ursuant to Section 2 lule coordinators su nt, they will put the ive prerequisites ca or whose registratio nent. If a student tak	to Subsection bsequently student's re- in successful- in for an as- kes an as-
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Module title					Abbreviation		
Introduction to Topology					10-M-TOP-152-m01		
Module coordinator				Module offered by			
Dean of Studies Mathematik (Mathematics			atics)	Institute of Mathematics			
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
5	(not) s	successfully completed					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts	U U	L				
les and compac	constr ctness,	uctions of topological sp	aces, quotients, conv	vergence of sequenc	properties, connectivity, examp- es and nets, different notions of aß, Arzela-Ascoli and Baire, and		
Intende	ed learı	ning outcomes					
is able	to appl		gebra and analysis to		as the pertinent proof methods, ses the broad applicability of the		
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)			
V (2) +	Ü (2)						
	Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus)						
(15 to 3 Assessi	o minu ment o ge of a	tes) or c) oral examinatic ffered: In the semester in ssessment: German and,	on in groups (groups of which the course is a	of 2, 10 to 15 minutes			
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teachir	ıg cycl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in							
Bachelor' degree (1 major) Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2015) Bachelor' degree (1 major) Computational Mathematics (2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)							

Module title					Abbreviation	
Mathematical Aspects of Modern Cryptography10-M-KRY-232-m01						
Module coordinator Module offe						
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mather	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
5	(not)	successfully completed				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	its	·	·			
		s of elementary number tl zation algorithm, post-qu			ematics of quantum computers,	
		ning outcomes				
The stu	ıdent k	-			mber theory, their application in ntum computers.	
Course	S (type, I	number of weekly contact hours, I	anguage — if other than Gei	rman)		
V (3) +	Ü (1)					
a) writt b) oral c) oral Langua	en exa examir examir age of a ment c semest ble for	er bonus	ach (15 to 30 minute of 2, 10 to 15 minutes /or English	s) or per candidate)	es are offered and in the subse-	
Additio	onal inf	ormation				
Worklo	ad					
150 h		_				
-						
Teachi	ng cyci	e				
Teachi						
Teachi		e LPOI (examination regulation	s for teaching-degree progra	mmes)		
Teachin Referre	ed to in	LPOI (examination regulation	s for teaching-degree progra	mmes)		
Teachin Referre Module	ed to in e appea	LPOI (examination regulation		immes)		
Teachin Referre Module exchan	ed to in e appea	LPOI (examination regulation ars in gram Mathematics (2023))	
Teachin Referre Module Exchan	ed to in e appea age pro ate exa	LPOI (examination regulation) g degree Gymnasium)	

Module title				Abbreviation		
Computational Mathematics 10-M-COM-152-mo1					L	
Module coordinator Module offe				Module offered by		
Dean o	of Studies	Mathematik (Mathen	natics)	Institute of Mathem	atics	
ECTS	1	l of grading	Only after succ. con			
4		ccessfully completed				
Duratio	<u> </u>	Nodule level	Other prerequisites			
1 seme	ester u	Indergraduate				
Conten	· · · · ·					
		modern mathematical	software for symbolic	computation (e. g. N	Aathematica or Man	le) and nu-
			supplement the basic			
			olution of problems in			
		gral calculus; visualis			,, , , ,	
Intende	ed learni	ng outcomes				
			ed modern mathemati	cal software package	es, and is able to ass	sess their
		ation to solve mathem		、 、		
		mber of weekly contact hours	, language — if other than Ger	rman)		
V(1) +						
	s creditable		uage — if other than German,	examination offered — if no	t every semester, informati	on on whether
			kercises (approx. 20 to	25 hours)		
		ered: Once a year, wir		25 110013)		
		sessment: German an				
Allocat	tion of pla	aces				
Additio	onal infor	rmation				
Worklo	bad					
120 h						
Teachi	ng cycle					
Referre	ed to in L	PO I (examination regulation	ons for teaching-degree progra	mmes)		
§ 22						
_	e appears	s in				
		e (1 major) Mathemat	ics (2015)			
	-	e (1 major) Physics (2	-			
Bachel	lor' degre	e (1 major) Nanostruc	ture Technology (2015))		
Bachel	lor' degre	e (1 major) Economatl	hematics (2015)			
Bachel	lor' degre	e (1 major) Mathemat	ical Physics (2015)			
Bachel	lor' degre	e (1 major) Computati	onal Mathematics (20	15)		
Bachel	lor' degre	e (1 major) Functional	Materials (2015)			
			ng degree Gymnasium	Mathematics (2015)		
	-	e (1 major) Mathemat				
		e (1 major) Economatl				
			ng degree Gymnasium	Mathematics (2019)		
Bachel	lor' degre	e (1 major) Physics (2	020)			
	with 1 major	Mathematical Physics		generated 30-Mär-2024 • exa	-	page 146 / 160
(2024)			ta record Bachelo	r (180 ECTS) Mathematische I	Physik - 2024	

Bachelor' degree (1 major) Nanostructure Technology (2020) Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Functional Materials (2021) Bachelor' degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Economathematics (2021) Bachelor' degree (1 major) Economathematics (2022) Bachelor' degree (1 major) Mathematical Data Science (2022) exchange program Mathematics (2023) First state examination for the teaching degree Gymnasium Mathematics (2023) Bachelor' degree (1 major) Economathematics (2023) Bachelor' degree (1 major) Economathematics (2023) Bachelor' degree (1 major) Economathematics (2023)

Module	title			_	Abbreviation	
Programming course for students of Mathematics and other subjects					10-M-PRG-152-m01	
Module	coord	inator		Module offered by	I	
		es Mathematik (Mathem	natics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com			
3		successfully completed				
<u> </u>		Module level	Other prerequisites			
1 seme		undergraduate				
Conten		undergraduate				
		odern programming lang	guage (e. g. C).			
		ning outcomes				
The stu in math		able to work independers.	ently on small program	iming exercises and	standard programm	ing problems
Course	S (type, n	umber of weekly contact hours	language — if other than Ger	man)		
P (2)						
		essment (type, scope, langule for bonus)	age — if other than German, e	examination offered — if no	ot every semester, informati	ion on whether
		form of programming ex	ercises (approx. 20 to	25 hours)		
		ffered: Once a year, sun				
Langua	ge of a	ssessment: German and	l/or English			
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
90 h						
Teachir	ng cycl	9				
Referre	d to in	LPO I (examination regulatio	ns for teaching-degree progra	mmes)		
§ 22						
Module		rs in				
		ree (1 major) Mathemati	(5 (2015)			
	-	ree (1 major) Physics (20	-			
	-	ree (1 major) Nanostruct		1		
Bachel	or' degi	ree (1 major) Economatł	nematics (2015)			
Bachel	or' deg	ree (1 major) Mathemati	cal Physics (2015)			
	-	ree (1 major) Computati		15)		
	-	ree (1 major) Functional	_			
		mination for the teachir		Mathematics (2015)		
	-	ree (1 major) Mathemati				
	-	ree (1 major) Economath mination for the teachir		Mathematics (2010)		
		ree (1 major) Physics (20		mathematics (2019)		
	-	ree (1 major) Nanostruct)		
	-	ree (1 major) Mathemati				
	-	ree (1 major) Functional				
Bachelor's (2024)	with 1 maj	or Mathematical Physics	_	generated 30-Mär-2024 • ex r (180 ECTS) Mathematische	-	page 148 / 160

Bachelor' degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Economathematics (2021) Bachelor' degree (1 major) Economathematics (2022) Bachelor' degree (1 major) Mathematical Data Science (2022) exchange program Mathematics (2023) First state examination for the teaching degree Gymnasium Mathematics (2023) Bachelor' degree (1 major) Mathematics (2023) Bachelor' degree (1 major) Economathematics (2023) Bachelor' degree (1 major) Mathematical Physics (2024) Bachelor' degree (1 major) Economathematics (2024)

Module	e title				Abbreviation	
Selected Topics in History of Mathematics					10-M-GES-152-m01	
Module coordinator				Module offered by	1	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS		od of grading	Only after succ. com	pl. of module(s)		
5		successfully completed				
Duratio		Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
Historio the fun	cal and damen	cultural development as tals of mathematics, in p nematics in modern socie	oarticular in its relatio			
Intende	ed lear	ning outcomes				
tical th audien	eories a ce.	cted examples, the stud and their social relevance	e. He/she is able to p	resent mathematica		
		number of weekly contact hours, I	language — if other than Ger	man)		
V (2) +	<u> </u>					
		sessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	ot every semester, informat	tion on whether
a) talk Assess	(45 to 9 ment o	oo minutes) or b) term pa ffered: In the semester ir ssessment: German and	which the course is			r
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachi	ng cycl	e	-			
Referre	d to in	LPO I (examination regulation	s for teaching-degree progra	mmes)		
§ 22			0 - 0 - 1 - 1 - 0 - 1	· ·		
Module		urs in				
		ree (1 major) Mathematic	cs (2015)			
	-	ree (1 major) Mathematic	_			
		ree (1 major) Computatio		15)		
First sta	ate exa	mination for the teachinន	g degree Gymnasium	Mathematics (2015)		
	-	ree (1 major) Mathematic				
First state examination for the teaching degree Gymnasium Mathematics (2019)						
	-	ree (1 major) Mathematic		2)		
	-	ree (1 major) Mathematic gram Mathematics (2023		<i>∠)</i>		
		mination for the teaching		Mathematics (2023))	
		ree (1 major) Mathematic				
		ree (1 major) Mathematic				
Bachelor's	with 1 ma	or Mathematical Physics	IMII Würzhurg •	generated 30-Mär-2024 • ex	am. reg. da-	page 150 / 160
2024)			_	r (180 ECTS) Mathematische	-	puse 150 / 100

Module title				Abbreviation		
Mathematical Writing 10					10-M-MSC-152-m01	
Module coordinator Modu			Module offered by	odule offered by		
Dean o	Dean of Studies Mathematik (Mathematics) Institu			Institute of Mathem	atics	
ECTS	1	od of grading				
5		successfully completed		• • • •		
Duratio		Module level	Other prerequisites			
1 seme	ster	undergraduate	 			
Conten	ts		1			
Discus	sion of	good and bad mathema	tical writing using pra	ctical exercises and	case examples. The	course co-
		e range of mathematical				
		e works such as Bachel		s. Important aspects	include not only ma	thematical
		ciency but also didactic	questions.			
		ning outcomes				
		able to formulate math ctures and conventions				
-		number of weekly contact hours,				Vork.
V (2) +	-			many		
		Sessment (type, scope, langu	age — if other than German	examination offered — if no	t every semester informati	ion on whether
		le for bonus)			cevery semester, mornal	on on whether
a) talk	(45 to 9	o minutes) or b) term p	aper (10 to 15 pages) o	or c) project (15 to 25	hours)	
		ffered: In the semester i		offered and in the su	ubsequent semester	
		ssessment: German and	l/or English			
Allocat	ion of p	olaces				
			_			
Additio	onal inf	ormation				
Worklo	ad		-			
150 h	-		_			
Teachi	ng cycl	e				
			_			
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree progra	mmes)		
§ 22	Nr. 3 f)					
Module	e appea	nrs in				
	-	ree (1 major) Mathemati				
	-	ree (1 major) Mathemati	• •	、 、		
		ree (1 major) Computatio				
		mination for the teachin	,	Mathematics (2015)		
	-	ree (1 major) Mathemati		Mathematics (ages)		
		mination for the teachin ree (1 major) Mathemati	,	mainematics (2019)		
	-	ree (1 major) Mathemati		2)		
	-	gram Mathematics (202		<i>_</i>)		
		mination for the teaching		Mathematics (2023)		
		ree (1 major) Mathemati	,			
	-	ree (1 major) Mathemati	-			
Bachelor's	with 1 ma	or Mathematical Physics	IMU Würzhurø●	generated 30-Mär-2024 • exa	am. reg. da-	page 151 / 160
(2024)			-	r (180 ECTS) Mathematische I	-	

Module	e title				Abbreviation	
School Mathematics from a Higher Perspective 10-M-SCH-152-mo1						
Module coordinator Module offered by						
Dean o	f Studi	es Mathematik (Mather	matics)	Institute of Mathem	atics	
ECTS	r –	od of grading	Only after succ. con		<u></u>	
		successfully completed				
5 Duratio		Module level				
			Other prerequisites			
1 seme		undergraduate				
Conten						
		selected topics in scho implementation at both			ation into wider theo	ories and
Intende	ed lear	ning outcomes				
and ad thodica	vanced al aspe		s. He/She is able to dis	cuss these under ma		
	-	number of weekly contact hour	s, language — if other than Ger	man)		
V (2) +	Ü (2)					
Methoo	d of ass	Sessment (type, scope, lang	uage — if other than German, o	examination offered — if no	ot every semester, informat	ion on whether
		le for bonus)				
Assess Langua	ment o ge of a	<. 45 minutes) or b) terr ffered: In the semester ssessment: German an	in which the course is			
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachi	ng cycl	e				
 D = f =				`		
		LPO I (examination regulation	ons for teaching-degree progra	mmes)		
§ 22 § 22	-					
§ 22 § 22						
Module	_	are in				
		ree (1 major) Mathemat	ics (2015)			
	-	ree (1 major) Mathemat				
	-	ree (1 major) Mathemat		15)		
	-)	
First state examination for the teaching degree Grundschule Mathematics (2015) First state examination for the teaching degree Realschule Mathematics (2015)						
		mination for the teachi				
		mination for the teachi				
		ree (1 major) Mathemat				
	-	mination for the teachi		Mathematics (2019)		
	ate exa	mination for the teachi	ng degree Mittelschule	Mathematics (2020	(Prüfungsordnungs	version
2015))						
achelor's 2024)	with 1 ma	or Mathematical Physics	_	generated 30-Mär-2024 • ex r (180 ECTS) Mathematische	-	page 152 / 160
7/					,	

Bachelor' degree (1 major) Mathematical Physics (2020) Bachelor' degree (1 major) Mathematical Data Science (2022) exchange program Mathematics (2023) First state examination for the teaching degree Gymnasium Mathematics (2023) Bachelor' degree (1 major) Mathematics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title Abbreviation						
Prosem	Proseminar Mathematics 10-M-PRO-152-m01					
Module	Module coordinator Module offered by					
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
4	(not)	successfully completed				
Duratio	'n	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	ts					
Selecte	d basi	c topics in mathematics.				
Intende	ed lear	ning outcomes				
of a giv	en top	•	•	-	sters elaboration and structuring /She is able to participate active-	
Course	S (type, 1	number of weekly contact hours, l	anguage — if other than Ger	rman)		
S (2)						
module is	creditat	le for bonus)	ge — if other than German, o	examination offered — if no	ot every semester, information on whether	
Assess	ment o	o minutes) Iffered: In the semester in Issessment: German and,		offered		
Allocat	ion of _l	places				
Additio	nal inf	ormation				
Worklo	ad					
120 h						
Teachi	ng cycl	e				
Referre	d to in	LPOI (examination regulation	s for teaching-degree progra	immes)		
Module	appea	ars in				
	-	ree (1 major) Mathematic				
	Bachelor' degree (1 major) Mathematical Physics (2015)					
	-	ree (1 major) Computatio		15)		
	Bachelor' degree (1 major) Mathematical Physics (2016)					
	-	ree (1 major) Mathematic	-			
		gram Mathematics (2023) ree (1 major) Mathematic				
	-	ree (1 major) Mathematic				
Suchet	or acg	ree (1 major) mathematic	(2024)			

Module title				Abbreviation		
Mathematical Methods of Physics					11-M-MR-202-m01	
Module coordinator Module offered by						
			a a ratical Dhusias	· · · ·	nd Actronomy	
and As	-	ector of the Institute of T sics	reoretical Physics	Faculty of Physics a	na Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	(not) s	successfully completed				
Duratio	n	Module level	Other prerequisites	i		
2 seme	ster	undergraduate				
Conten	ts					
Germar	n conte	nts available but not tra	nslated yet.			
		er Mathematik und elem ′orbereitung auf die Mod				
-	ed lear	ning outcomes				
Germar	n inten	ded learning outcomes a	vailable but not trans	slated yet.		
		erende verfügt über die I lche in der Theoretische				ren Rechen-
Course	S (type, r	number of weekly contact hours,	language — if other than Ge	rman)		
		V (2) + Ü (2) t in: German or English				
		Sessment (type, scope, langua Ile for bonus)	age — if other than German,	examination offered — if no	t every semester, informat	ion on whether
Exercis	es (suc	cessful completion of a	prox. 50% of approx.	. 13 exercise sheets)	or	
		15 minutes)		· · ·		
Allocat	ion of _l	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
Referre	d to in	LPOI (examination regulation	s for teaching-degree progra	ammes)		
§ 53 N	lr. 1 a)					
§ 77 N Module		ars in				
		ree (1 major) Physics (20	20)			
	-	ree (1 major) Nanostruct	•, •))		
	-	ree (1 major) Mathematio	•			
		gree (1 major, 1 minor) P				
		mination for the teaching		•		
		mination for the teachin mination for the teachin	,	•		
		mination for the teaching		-		
		jor Mathematical Physics		generated 30-Mär-2024 • ex	am. reg. da-	page 155 / 160
(2024)				r (180 ECTS) Mathematische		



Bachelor' degree (1 major) Quantum Technology (2021) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)

Module title				Abbreviation			
Comput	Computational Physics 11-CP-152-m01						
Module	coord	inator		Module offered by			
Managing Director of the Institute of Theoretical PhysicsFaculty of Physics and Astronomyand AstrophysicsFaculty of Physics and Astronomy							
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts						
 n si g ra 	 Introduction to programming on the basis of C++ / Java /Mathematica numerical solution of differential equations simulation of chaotic systems generation of random numbers random walk many-particle processes and reaction-diffusion model 						
Intende	ed learr	ning outcomes					
They ha	ave kno	nave knowledge of two n wledge of numerical sta ysical problems, e.g. alg	ndard methods and a	are able to apply com	puter-assisted proc		
Course	S (type, n	umber of weekly contact hours,	language — if other than Ge	rman)			
V (3) + I Module		t in: German or English					
		essment (type, scope, langua	age — if other than German,	examination offered — if no	t every semester, informat	ion on whether	
		le for bonus)					
or oral o pages) If a writ stead ta of asse nation o Assesse Langua	examin or pres ten exa ake the ssment date at ment o ge of a	nation (approx. 90 to 120 ation in groups (groups entation/talk (approx. 3 amination was chosen as form of an oral examina t is changed, the lecture the latest. ffered: Once a year, wint ssessment: German and	of 2, approx. 30 minu o minutes). 5 method of assessm tion of one candidate r must inform student er semester	ites per candidate) o ent, this may be chai e each or an oral exa	r project report (app nged and assessmer mination in groups.	rox. 8 to 10 nt may in- If the method	
Allocat	ion of p	olaces					
Additio	nal info	ormation					
Worklo	ad						
180 h			-				
Teachir	ng cycl	e					
			_				
Referre	d to in	LPO I (examination regulation	s for teaching-degree progra	ammes)			
Module	appea	in					
	-	ree (1 major) Physics (20 ree (1 major) Mathematio	-				
Bachelor's (2024)	with 1 maj	or Mathematical Physics	-	generated 30-Mär-2024 • exa r (180 ECTS) Mathematische I	-	page 157 / 160	

Bachelor's degree (1 major, 1 minor) Physics (Minor, 2015) Bachelor' degree (1 major) Mathematical Physics (2016) Bachelor' degree (1 major) Physics (2020) Bachelor' degree (1 major, 1 minor) Physics (2020) Bachelor's degree (1 major, 1 minor) Physics (Minor, 2020) exchange program Physics (2023) Bachelor' degree (1 major) Mathematical Physics (2024)



Thesis (10 ECTS credits)

Module	Module title Abbreviation					
Bachelor Thesis Mathematical Physics 10-M-BAP-152-m01						
Module coordinator Module offered by					<u> </u>	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate	Where applicable, to	opic-specific module	es as specified by supervisor.	
Conten	ts					
		y researching and writing ation with the supervisor		erdisciplinary) topic i	in mathematics or physics selec-	
Intend	ed lear	ning outcomes				
and ap	ply the				topic in mathematics or physics e can write down the result of	
Course	S (type, r	number of weekly contact hours,	language — if other than Ger	rman)		
No cou	rses as	signed to module				
		Sessment (type, scope, langua le for bonus)	age — if other than German, o	examination offered — if no	ot every semester, information on whether	
written	thesis	(approx. 250 to 300 hou	rs total)			
Allocat	ion of _l	olaces				
	-					
Additio	onal inf	ormation				
Time to	comp	ete: 10 weeks.	-			
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	mmes)		
Module						
	-	ree (1 major) Mathematic	,			
	-	ree (1 major) Mathematic	-			
	-	ree (1 major) Mathematic ree (1 major) Mathematic	•			
Dachel	or ueg		at i flysics (2024)			