

Subdivided Module Catalogue for the Subject

Quantum Engineering

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

Examination regulations version: 2024 Responsible: Faculty of Physics and Astronomy

JMU Würzburg • generated 02-Apr-2024 • exam. reg. data record 88|j43|-|-|H|2024

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Learning Outcomes

German contents and learning outcome available but not translated yet.

- After having successfully completed their studies the graduates fulfil the following
 - The graduates have the ability to abstract, they are able to think analytically, they have a strong problem-solving competence and are able to structure complex issues.
 - The graduates have a broad overview of the different areas of nanostructure engineering and of interdisciplinary synergies.
 - They have profound knowledge of the physical and technical basics of nanostructure enginering as well as deep knowledge of the theoretical and experimental methods to gain new insights.
 - They are able to apply their abilities and expertise to their own research projects and know the current state of research in at least one specialized field of nanostructure engineering.
 - With the help of primary literature, especially in English, they are able to become acquainted with the current state of research in a specialist field and are able to apply physical and technical methods self-reliantly to concrete tasks, to develop solutions and to interpret and assess results.
 - Even with incomplete information they are in a position to work self-reliantly on problems of nanostructure engineering, applying scientific methods and following the rules of good scientific practice, and to present and assess the results and consequences of their work.
 - They are able to discuss physical and technical topics on the current state of research with other nanostructure engineers/scientists and also to explain physical correlations to non-They are able to work as responsible scientists in interdisciplinary and international teams with (natural) scientists and/or engineers in research, industry and economy.

Scientific qualification

- The graduates have profound knowledge of the physical and technical basics of nanostructure engineering.
- The graduates can access profound knowledge of the theoretical and experimental methods to gain new insights.
- The graduates possess a broad overview of the complete area of nanostructure engineering.
- The graduates have an overview of the adjacent areas and interdisciplinary correlations.
- The graduates have the ability to abstract, they are able to think analytically, they have a high problem-solving competence and are able to structure complex correlations.
- The graduates transfer their abilities and expertise to their own research projects and know the current state of research in at least one specialist field of nanostructure engineering.
- The graduates are able to discuss physical and technical topics on the current state of research with other nanostructure engineers/scientists.
- The graduates are able to apply physical and technical methods self-reliantly to concrete experimental or theoretical tasks, to develop solutions and to interpret and assess the results.
- With the help of primary literature, especially in English, the graduates have the ability to become acquainted with the current state of research in a specialist field of nanostructure engineering.

Qualification to start a job

- Even with incomplete information the graduates are in a position to work self-reliantly on physical and technical problems, applying scientific methods and following the rules of good scientific practice, and to present, assess and attend to the results and consequences of their work.
- The graduates are able to work as responsible scientists in interdisciplinary and international teams with (natural) scientists and/or engineers in research, industry and economy.
- The graduates have the ability to apply physical and technical methods self-reliantly to concrete tasks, to develop solutions and to interpret and assess the results.

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• The graduates are in a position to transfer their abilities and expertise to their own research projects and know the current state of research in at least one specialist field of nanostructure engineering.

Self-development

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- Even with incomplete information the graduates are able to work self-reliantly on problems of nanostructure engineering, applying scientific methods, and to present, assess and attend to the results and consequences of their work.
- The graduates know the rules of good scientific practice and take them into account.

Qualification for social commitment

- The graduates are able to critically reflect natural scientific and technical developments and to capture their impact on economy, society and environment. (technological impact assessment).
- The graduates have deepened their knowledge concerning economic, social, natural scientific or cultural questions (to name but a few) and are able to attend to their views reasonably.
- The graduates are able to discuss physical and technical topics on the current state of research with other nanostructure engineers/scientists and also to explain physical correlations to non-scientists.
- The graduates have developed the willingness and ability to show their skills in participative processes and actively contribute to decisions.

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 (2023-71)

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

The subject is divided into

InterviewCreatistySubfield Quantum Engineering (min. 55 ECTS credits)Advanced Laboratory Courses (min. 9 ECTS credits)Advanced Laboratory Course Master Part 13B/NB6611-PFM3-Int-201-monAdvanced Laboratory Course Master Part 23B/NB6811-PFM3-Int-201-monAdvanced Laboratory Course Master Part 33B/NB6911-PFM3-Int-201-monAdvanced Laboratory Course Master Part 33B/NB69Advanced Seminar Quantum Engineering A5NUM6411-OSN-A-Int-201-monAdvanced Seminar Quantum Engineering5NUM6411-OSN-A-Int-201-monAdvanced Seminar Quantum Engineering6NUM5411-HPH-Int-201-monOptical Properties of Semiconductor Nanostructures6NUM56Specialization Quantum Transport6NUM5211-SPH-Int-201-monQuantum Transport6NUM6211-SPH-Int-201-monSpintronics6NUM6211-SPH-Int-201-monMage and Signal Processing In Physics6NUM5911-SPH-Int-201-monOrganic Semiconductors6NUM630Sinturue-Properties Correlations of Light Materials - Experi- 15NUM100Sinturue-Properties Correlations of Light Materials - Experi- 16NUM33	Abbreviation	Module title		Method of	page					
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11-NOP-Int-201-m01Nano-Optics6NUM6211-SPI-Int-201-m01Spintronics6NUM7911-BSV-Int-201-m01Physics of Advanced Materials6NUM2911-PMM-Int-201-m01Organic Semiconductors6NUM6308-FU-SAM-161-m01Sensor and Actor Materials - Functional Ceramics and Magneric Particles5NUM1008-FU-SAM-161-m01Ultrafast spectroscopy and quantum-control5NUM808-FU-SEW-222-m01Electrochemical Energy Storage and Conversion5NUM808-FU-MW-222-m01Current Topics in Quantum Engineering5NUM3411-EXNS-Int-241-m01Current Topics in Quantum Engineering5NUM3311-EXNS-Int-241-m01Current Topics in Quantum Engineering6NUM3311-EXNS-Int-241-m01Current Topics in Quantum Engineering6NUM3311-EXNS-Int-241-m01Current Topics in Quantum Engineering6NUM3311-EXNS-Int-241-m01Advanced Topics in Quantum Engineering6NUM3311-CSFM-Int-201-m01Advanced Topics in Solid State Physics6NUM3311-CSFM-Int-201-m01Solid State Physics6NUM3311-CSFM-Int-201-m01Solid State Physics6NUM3311-CSFM-Int-201-m01Solid State Physics6NUM3311-CSFM-Int-201-m01Solid State Physics6NUM3311-CSFM-Int-201-m01Solid State Spectrocopy <td>11-QTR-Int-201-m01</td> <td>Quantum Transport</td> <td>6</td> <td>NUM</td> <td>77</td>	11-QTR-Int-201-m01	Quantum Transport	6	NUM	77					
11-SPI-Int-201-m01Spintronics6NUM7911-BSV-Int-201-m01Image and Signal Processing in Physics6NUM2911-PMM-Int-201-m01Physics of Advanced Materials6NUM7011-OHL-Int-201-m01Organic Semiconductors6NUM6308-FU-SAM-161-m01Sensor and Actor Materials - Functional Ceramics and Magneric Particles5NUM1108-FU-SAM-161-m01Ultrafast spectroscopy and quantum-control5NUM808-FU-MW-222-m01Electrochemical Energy Storage and Conversion5NUM808-FU-MW-222-m01Structure-Properties Correlations of Light Materials - Experiments and Numerical Simulations5NUM3411-EXNS-Int-241-m01Current Topics in Quantum Engineering5NUM3611-EXNS-Int-241-m01current Topics in Quantum Engineering6NUM3311-EXNS-Int-241-m01current Topics in Quantum Engineering6NUM3311-EXNS-Int-241-m01current Topics in Quantum Engineering6NUM3311-CSSM-Int-241-m01Advanced Topics in Solid State Physics6NUM3311-CSSM-Int-201-m01Advanced Topics in Quantum Engineering6NUM3311-CSSM-Int-201-m01Advanced Topics in Solid State Physics6NUM3311-CSSM-Int-201-m01Advanced Topics in Physics6NUM3311-CSSM-Int-201-m01Solid State Physics8NUM4911-FK-Int-201-m01Solid State Physics<	11-NOP-Int-201-m01	Nano-Optics	6	NUM	62					
11-BSV-Int-201-m01Image and Signal Processing in Physics6NUM2911-PMM-Int-201-m01Physics of Advanced Materials6NUM6311-OHL-Int-201-m01Organic Semiconductors6NUM6308-FU-SAM-161-m01Sensor and Actor Materials - Functional Ceramics and Magneric Particles5NUM1108-FU-SAM-161-m01Ultrafast spectroscopy and quantum-control5NUM1108-FU-EEW-222-m01Electrochemical Energy Storage and Conversion5NUM808-FU-MW-222-m01Structure-Properties Correlations of Light Materials - Experiments and Numerical Simulations5NUM3411-EXNS-Int-241-m01Current Topics in Quantum Engineering5NUM3611-EXNS-Int-241-m01current Topics in Quantum Engineering6NUM3311-EXNAA-Int-241-m01current Topics in Quantum Engineering6NUM3311-EXNAA-Int-241-m01current Topics in Quantum Engineering6NUM3311-CSFM-Int-201-m01Advanced Topics in Quantum Engineering6NUM3311-CSFM-Int-201-m01Advanced Topics in Quantum Engineering6NUM3311-CSFM-Int-201-m01Solid State Physics6NUM3311-CSFM-Int-201-m01Advanced Topics in Solid State Physics6NUM3311-CSFM-Int-201-m01Solid State Physics6NUM3311-CSFM-Int-201-m01Solid State Physics8NUM3411-FK-Int-201-m01Solid State Ph	11-SPI-Int-201-m01	Spintronics	6	NUM	79					
11-PMM-Int-201-monPhysics of Advanced Materials66NUM7011:OHL-Int-201-monOrganic Semiconductors66NUM6308-FU-SAM-161-monSensor and Actor Materials - Functional Ceramics and Magner tic Particles5NUM1008-FU-SAM-161-monUltrafast spectroscopy and quantum-control5NUM1108-FU-EEW-222-monElectrochemical Energy Storage and Conversion5NUM808-FU-MW-222-monStructure-Properties Correlations of Light Materials - Experi- ments and Numerical Simulations5NUM3411-EXN5-Int-241-monCurrent Topics in Quantum Engineering5NUM3611-EXN6-Int-241-monCurrent Topics in Quantum Engineering6NUM3611-EXN6-Int-241-monCurrent Topics in Quantum Engineering6NUM3611-EXN6-Int-241-monCurrent Topics in Quantum Engineering6NUM3111-EXN6-Int-241-monAdvanced Topics in Solid State Physics6NUM3111-CSPM-Int-201-monAdvanced Topics in Quantum Engineering6NUM3111-CSPM-Int-201-monSolid State Physics 28NUM3211-CSPM-Int-201-monSolid State Physics6NUM3211-CSPM-Int-201-monSolid State Spectrocopy6NUM3211-CSPM-Int-201-monSolid State Spectrocopy6NUM3211-CSPM-Int-201-monSolid State Physics8NUM4211-FK-Int-201-monSolid State Physics8	11-BSV-Int-201-m01	Image and Signal Processing in Physics	6	NUM	29					
11-OHL-Int-201-monOrganic Semiconductors6NUM6308-FU-SAM-161-monSensor and Actor Materials - Functional Ceramics and Magneric Particles5NUM1008-FU-SAM-161-monUltrafast spectroscopy and quantum-control5NUM1108-FU-EEW-222-monElectrochemical Energy Storage and Conversion5NUM808-FU-MW-222-monElectrochemical Simulations5NUM3408-FU-MW-222-monStructure-Properties Correlations of Light Materials - Experiments and Numerical Simulations5NUM3411-EXN5-Int-241-mocurrent Topics in Quantum Engineering6NUM3611-EXN6-Int-241-mo1current Topics in Quantum Engineering6NUM3711-EXN6A-Int-241-mo1current Topics in Quantum Engineering6NUM3611-CSFM-Int-241-mo1current Topics in Quantum Engineering6NUM3011-CSFM-Int-241-mo1Advanced Topics in Solid State Physics6NUM3111-CSFM-Int-201-mo1Solid State Physics 28NUM3111-CSFM-Int-201-mo1Electron and Ion Microscopy6NUM3111-CSFM-Int-201-mo1Solid State Physics8NUM4711-TEK-Int-201-mo1Solid State Physics8NUM3111-CSFM-Int-201-mo1Selected Topics of Theoretical Solid State Physics8NUM3211-CSFM-Int-201-mo1Field Theory in Solid State Physics8NUM3111-TEK-Int-201-mo1Field Theory in Sol	11-PMM-Int-201-m01	Physics of Advanced Materials	6	NUM	70					
o8-FU-SAM-161-mo1Sensor and Actor Materials - Functional Ceramics and Magneric Particles5NUM10o8-FU-SAM-161-mo1Ultrafast spectroscopy and quantum-control5NUM11o8-FU-EEW-222-mo1Electrochemical Energy Storage and Conversion5NUM8o8-FU-MW-222-mo1Structure-Properties Correlations of Light Materials - Experiments and Numerical Simulations5NUM3411-EXN5-Int-241-mo1current Topics in Quantum Engineering6NUM3611-EXN6-Int-241-mo1current Topics in Quantum Engineering7NUM3711-EXN6-Int-241-mo1current Topics in Quantum Engineering6NUM3611-EXN6-Int-241-mo1current Topics in Quantum Engineering6NUM3011-CSFM-Int-241-mo1dvanced Topics in Solid State Physics6NUM3011-CSFM-Int-201-mo1Advanced Topics in Quantum Engineering6NUM3011-CSFM-Int-201-mo1Solid State Physics 28NUM3111-FK2-Int-201-mo1Solid State Physics 28NUM3111-CSFM-Int-201-mo1Solid State Spectrocopy6NUM3211-CSFM-Int-201-mo1Solid State Physics8NUM4711-FKS-Int-201-mo1Solid State Physics8NUM3411-CSFM-Int-201-mo1Solid State Physics8NUM3211-CSFM-Int-201-mo1Solid State Physics8NUM4711-FKS-Int-201-mo1Solid State Spectrocopy6NUM34 </td <td>11-OHL-Int-201-m01</td> <td>Organic Semiconductors</td> <td>6</td> <td>NUM</td> <td>63</td>	11-OHL-Int-201-m01	Organic Semiconductors	6	NUM	63					
o8-PCM4-161-mo1Ultrafast spectroscopy and quantum-control5NUM11o8-FU-EEW-222-mo1Electrochemical Energy Storage and Conversion5NUM8o8-FU-MW-222-mo1Structure-Properties Correlations of Light Materials - Experiments and Numerical Simulations5NUM3411-EXN5-Int-241-mo1Current Topics in Quantum Engineering5NUM3611-EXN7-Int-241-mo1Current Topics in Quantum Engineering6NUM3611-EXN8-Int-241-mo1Current Topics in Quantum Engineering7NUM3711-EXN8-Int-241-mo1Current Topics in Quantum Engineering6NUM3811-EXN6-Int-241-mo1Current Topics in Quantum Engineering6NUM3511-CSFM-Int-201-mo1Advanced Topics in Quantum Engineering6NUM3011-CSNM-Int-241-mo1Solid State Physics 28NUM4911-EXN6-Int-201-mo1Solid State Physics 28NUM3311-CSPM-Int-201-mo1Solid State Spectrocopy6NUM3211-FKK-Int-201-mo1Solid State Spectrocopy6NUM8111-FKK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-mo1Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-mo1Gelected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-mo1Field Theory in Solid State Physics6NUM2411-MAG-Int-201-mo1Gelected Topic	08-FU-SAM-161-m01	Sensor and Actor Materials - Functional Ceramics and Magne- tic Particles	5	NUM	10					
o8-FU-EEW-222-m01Electrochemical Energy Storage and Conversion5NUM8o8-FU-MW-222-m01Structure-Properties Correlations of Light Materials - Experiments and Numerical Simulations5NUM911-EXN5-Int-241-m01Current Topics in Quantum Engineering5NUM3411-EXN6-Int-241-m01Current Topics in Quantum Engineering6NUM3611-EXN7-Int-241-m01Current Topics in Quantum Engineering7NUM3711-EXN8-Int-241-m01Current Topics in Quantum Engineering8NUM3811-EXN6A-Int-241-m01Current Topics in Quantum Engineering6NUM3511-EXN6A-Int-241-m01Current Topics in Quantum Engineering6NUM3811-EXN6A-Int-241-m01Current Topics in Quantum Engineering6NUM3011-EXN6A-Int-241-m01Current Topics in Solid State Physics6NUM3011-CSFM-Int-201-m01Advanced Topics in Solid State Physics6NUM3111-FK2-Int-201-m01Solid State Physics 28NUM4911-EKN-Int-201-m01Electron and Ion Microscopy6NUM3211-FKS-Int-201-m01Solid State Spectrocopy6NUM8111-FK-Int-201-m01Solid State Spectrocopy6NUM4711-AKTF-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MG-Int-201-m01Regressin Solid Sta	08-PCM4-161-m01	Ultrafast spectroscopy and quantum-control	5	NUM	11					
o8-FU-MW-222-mo1Structure-Properties Correlations of Light Materials - Experiments and Numerical Simulations5NUM911-EXN5-Int-241-mo1Current Topics in Quantum Engineering5NUM3411-EXN6-Int-241-mo1Current Topics in Quantum Engineering6NUM3611-EXN7-Int-241-mo1Current Topics in Quantum Engineering7NUM3711-EXN8-Int-241-mo1Current Topics in Quantum Engineering8NUM3811-EXN6A-Int-241-mo1Current Topics in Quantum Engineering6NUM3511-EXN6A-Int-241-mo1Current Topics in Quantum Engineering6NUM3611-EXN6A-Int-241-mo1Current Topics in Quantum Engineering6NUM3111-EXN6A-Int-241-mo1Advanced Topics in Solid State Physics6NUM3011-CSFM-Int-201-mo1Advanced Topics in Quantum Engineering6NUM3111-FK2-Int-201-mo1Solid State Physics 28NUM4911-EIM-Int-201-mo1Electron and Ion Microscopy6NUM3211-FKS-Int-201-mo1Solid State Spectrocopy6NUM5111-TEFK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-mo1Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-mo1Magnetism6NUM5711-QU2-Int-201-mo1Quantum Mechanics II8NUM7511-QU2-Int-221-mo1Theoretical Quantum Optics8NUM	08-FU-EEW-222-m01	Electrochemical Energy Storage and Conversion	5	NUM	8					
08-HU-MW-222-mo1 ments and Numerical Simulations5NUM911-EXN5-Int-241-mo1Current Topics in Quantum Engineering5NUM3411-EXN6-Int-241-mo1Current Topics in Quantum Engineering6NUM3611-EXN8-Int-241-mo1Current Topics in Quantum Engineering7NUM3711-EXN8-Int-241-mo1Current Topics in Quantum Engineering8NUM3811-EXN6A-Int-241-mo1Current Topics in Quantum Engineering6NUM3511-CSFM-Int-201-mo1Advanced Topics in Solid State Physics6NUM3011-CSNM-Int-201-mo1Advanced Topics in Quantum Engineering6NUM3111-FK2-Int-201-mo1Solid State Physics 28NUM4911-EIM-Int-201-mo1Electron and Ion Microscopy6NUM3211-FKS-Int-201-mo1Solid State Spectrocopy6NUM3211-FKS-Int-201-mo1Field Theory in Solid State Physics8NUM4711-FK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-FK-Int-201-mo1Solid State Spectrocopy6NUM3111-FFK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-mo1Selected Topics of Theoretical Solid State Physics6NUM3711-TGM2-Int-201-mo1Magnetism6NUM5711-QM2-Int-201-mo1Quantum Mechanics II8NUM7511-TQO-Int-221-mo1Theoretical Quantum Optics </td <td></td> <td>Structure-Properties Correlations of Light Materials - Experi-</td> <td></td> <td></td> <td></td>		Structure-Properties Correlations of Light Materials - Experi-								
11-EXN5-Int-241-mo1Current Topics in Quantum Engineering5NUM3411-EXN6-Int-241-mo1Current Topics in Quantum Engineering6NUM3611-EXN7-Int-241-mo1Current Topics in Quantum Engineering7NUM3711-EXN8-Int-241-mo1Current Topics in Quantum Engineering8NUM3811-EXN6A-Int-241-mo1Current Topics in Quantum Engineering6NUM3511-CSFM-Int-201-mo1Advanced Topics in Solid State Physics6NUM3011-CSNM-Int-241-mo1Solid State Physics 28NUM4911-FK2-Int-201-mo1Solid State Physics 28NUM3311-FK2-Int-201-mo1Electron and Ion Microscopy6NUM3211-FKS-Int-201-mo1Solid State Spectrocopy6NUM3111-FFK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-FFK-Int-201-mo1Selected Topics of Theoretical Solid State Physics8NUM4711-FFK-Int-201-mo1Field Theory in Solid State Physics6NUM2411-MAG-Int-201-mo1Field Theory in Solid State Physics6NUM2411-MAG-Int-201-mo1Getted Topics of Theoretical Solid State Physics6NUM5711-QM2-Int-201-mo1Quantum Mechanics II8NUM7511-TQO-Int-221-mo1Theoretical Quantum Optics8NUM85	08-FU-MW-222-m01	ments and Numerical Simulations	5	NUM	9					
11-EXN6-Int-241-m01Current Topics in Quantum Engineering6NUM3611-EXN7-Int-241-m01Current Topics in Quantum Engineering7NUM3711-EXN8-Int-241-m01Current Topics in Quantum Engineering8NUM3811-EXN6A-Int-241-m01Current Topics in Quantum Engineering6NUM3511-CSFM-Int-201-m01Advanced Topics in Solid State Physics6NUM3011-CSNM-Int-241-m01Solid State Physics 28NUM4911-FK2-Int-201-m01Solid State Physics 28NUM3311-CSPM-Int-201-m01Electron and Ion Microscopy6NUM3211-FKS-Int-201-m01Solid State Spectrocopy6NUM3211-FKS-Int-201-m01Field Theory in Solid State Physics8NUM4711-FFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-FFK-Int-201-m01Solid State Spectrocopy6NUM3211-TEFK-Int-201-m01Solid State Spectrocopy6NUM4711-TEFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Quantum Mechanics II8NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM85	11-EXN5-Int-241-m01	Current Topics in Quantum Engineering	5	NUM	34					
11-EXN7-Int-241-m01Current Topics in Quantum Engineering7NUM3711-EXN8-Int-241-m01Current Topics in Quantum Engineering8NUM3811-EXN6A-Int-241-m01Current Topics in Quantum Engineering6NUM3511-CSFM-Int-201-m01Advanced Topics in Solid State Physics6NUM3011-CSNM-Int-241-m01Advanced Topics in Quantum Engineering6NUM3111-CSNM-Int-201-m01Advanced Topics in Quantum Engineering6NUM3111-FK2-Int-201-m01Solid State Physics 28NUM4911-EIM-Int-201-m01Electron and Ion Microscopy6NUM3311-CSPM-Int-201-m01Advanced Topics in Physics6NUM3211-FKS-Int-201-m01Solid State Spectrocopy6NUM5111-TEFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Quantum Mechanics II8NUM5711-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-EXN6-Int-241-m01	Current Topics in Quantum Engineering	6	NUM	36					
11-EXN8-Int-241-mo1Current Topics in Quantum Engineering8NUM3811-EXN6A-Int-241-mo1Current Topics in Quantum Engineering6NUM3511-CSFM-Int-201-mo1Advanced Topics in Solid State Physics6NUM3011-CSNM-Int-241-mo1Advanced Topics in Quantum Engineering6NUM3111-FK2-Int-201-mo1Solid State Physics 28NUM4911-FK2-Int-201-mo1Electron and Ion Microscopy6NUM3311-CSPM-Int-201-mo1Electron and Ion Microscopy6NUM3211-FKS-Int-201-mo1Solid State Spectrocopy6NUM3211-FFK-Int-201-mo1Solid State Spectrocopy6NUM4711-FFK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-mo1Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-mo1Quantum Mechanics II8NUM7511-TQO-Int-221-mo1Theoretical Quantum Optics8NUM85	11-EXN7-Int-241-m01	Current Topics in Quantum Engineering	7	NUM	37					
11-EXN6A-Int-241-mo1Current Topics in Quantum Engineering6NUM3511-CSFM-Int-201-mo1Advanced Topics in Solid State Physics6NUM3011-CSNM-Int-241-mo1Advanced Topics in Quantum Engineering6NUM3111-FK2-Int-201-mo1Solid State Physics 28NUM4911-EIM-Int-201-mo1Electron and Ion Microscopy6NUM3311-CSPM-Int-201-mo1Advanced Topics in Physics6NUM3211-FKS-Int-201-mo1Solid State Spectrocopy6NUM5111-TEFK-Int-201-mo1Solid State Spectrocopy6NUM4711-TEFK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-mo1Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-mo1Quantum Mechanics II8NUM7511-TQO-Int-221-mo1Theoretical Quantum Optics8NUM85	11-EXN8-Int-241-m01	Current Topics in Quantum Engineering	8	NUM	38					
11-CSFM-Int-201-m01Advanced Topics in Solid State Physics6NUM3011-CSNM-Int-241-m01Advanced Topics in Quantum Engineering6NUM3111-FK2-Int-201-m01Solid State Physics 28NUM4911-EIM-Int-201-m01Electron and Ion Microscopy6NUM3311-CSPM-Int-201-m01Advanced Topics in Physics6NUM3211-CSPM-Int-201-m01Solid State Spectrocopy6NUM5111-FKS-Int-201-m01Solid State Spectrocopy6NUM5111-TEFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Quantum Mechanics II8NUM5711-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-EXN6A-Int-241-m01	Current Topics in Quantum Engineering	6	NUM	35					
11-CSNM-Int-241-mo1Advanced Topics in Quantum Engineering6NUM3111-FK2-Int-201-mo1Solid State Physics 28NUM4911-EIM-Int-201-mo1Electron and Ion Microscopy6NUM3311-CSPM-Int-201-mo1Advanced Topics in Physics6NUM3211-FKS-Int-201-mo1Solid State Spectrocopy6NUM5111-FFK-Int-201-mo1Topological Effects in Solid State Physics8NUM8111-FFK-Int-201-mo1Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-mo1Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-mo1Magnetism6NUM5711-QM2-Int-201-mo1Quantum Mechanics II8NUM7511-TQO-Int-221-mo1Theoretical Quantum Optics8NUM85	11-CSFM-Int-201-m01	Advanced Topics in Solid State Physics	6	NUM	30					
11-FK2-Int-201-m01Solid State Physics 28NUM4911-EIM-Int-201-m01Electron and Ion Microscopy6NUM3311-CSPM-Int-201-m01Advanced Topics in Physics6NUM3211-FKS-Int-201-m01Solid State Spectrocopy6NUM5111-TEFK-Int-201-m01Topological Effects in Solid State Physics8NUM8111-FFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-CSNM-Int-241-mo1	Advanced Topics in Quantum Engineering	6	NUM	31					
11-EIM-Int-201-m01Electron and Ion Microscopy6NUM3311-CSPM-Int-201-m01Advanced Topics in Physics6NUM3211-FKS-Int-201-m01Solid State Spectrocopy6NUM5111-TEFK-Int-201-m01Topological Effects in Solid State Physics8NUM8111-FFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-FK2-Int-201-m01	Solid State Physics 2	8	NUM	49					
11-CSPM-Int-201-m01Advanced Topics in Physics6NUM3211-FKS-Int-201-m01Solid State Spectrocopy6NUM5111-TEFK-Int-201-m01Topological Effects in Solid State Physics8NUM8111-FFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-EIM-Int-201-m01	Electron and Ion Microscopy	6	NUM	33					
11-FKS-Int-201-m01Solid State Spectrocopy6NUM5111-TEFK-Int-201-m01Topological Effects in Solid State Physics8NUM8111-FFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-CSPM-Int-201-m01	Advanced Topics in Physics	6	NUM	32					
11-TEFK-Int-201-m01Topological Effects in Solid State Physics8NUM8111-FFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-FKS-Int-201-m01	Solid State Spectrocopy	6	NUM	51					
11-FFK-Int-201-m01Field Theory in Solid State Physics8NUM4711-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-TEFK-Int-201-m01	Topological Effects in Solid State Physics	8	NUM	81					
11-AKTF-Int-201-m01Selected Topics of Theoretical Solid State Physics6NUM2411-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-FFK-Int-201-m01	Field Theory in Solid State Physics	8	NUM	47					
11-MAG-Int-201-m01Magnetism6NUM5711-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-AKTF-Int-201-m01	Selected Topics of Theoretical Solid State Physics	6	NUM	24					
11-QM2-Int-201-m01Quantum Mechanics II8NUM7511-TQO-Int-221-m01Theoretical Quantum Optics8NUM85	11-MAG-Int-201-m01	Magnetism	6	NUM	57					
11-TQO-Int-221-mo1 Theoretical Quantum Optics 8 NUM 85	11-QM2-Int-201-m01	Quantum Mechanics II	8	NUM	75					
	11-TQO-Int-221-m01	Theoretical Quantum Optics	8	NUM	85					

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11-TFK-Int-201-m01	Theoretical Solid State Physics	8	NUM	83
11-PTS-Int-201-m01	Phenomenology and Theory of Superconductivity	6	NUM	71
11-QIC-Int-201-m01	Advanced Theory of Quantum Computing and Quantum Infor- mation	6	NUM	73
11-MRI-Int-201-m01	Advanced Magnetic Resonance Imaging	6	NUM	60
11-SSC-Int-201-m01	Surface Science	6	NUM	80
11-FPA-Int-201-m01	Visiting Research	10	NUM	52
11-EXP5-Int-201-m01	Current Topics in Physics	5	NUM	40
11-EXP6-Int-201-m01	Current Topics in Physics	6	NUM	42
11-EXP7-Int-201-m01	Current Topics in Physics	7	NUM	43
11-EXP8-Int-201-m01	Current Topics in Physics	8	NUM	44
11-EXP6A-Int-201-m01	Current Topics in Physics	6	NUM	41
Subfield Nontechnical M	inors	°		
10-M-VAN-222-m01	Advanced Analysis	10	NUM	23
10-M=VDIMin-152-m01	Discrete Mathematics	5	NUM	22
10-l=QC-221-m01	Quantum Communications	5	NUM	16
10-I-APR-172-m01	Advanced Programming	5	NUM	18
10-I=DB-161-m01	Databases	5	NUM	13
10-l-BS-191-m01	Operating Systems	5	NUM	20
10-l=Kl1-212-m01	Artificial Intelligence 1	5	NUM	14
02-N-Ö-W2-05-152-m01	Environmental Law	3	NUM	7
11-AP-Int-201-m01	Astrophysics	6	NUM	25
11-ASM-Int-201-m01	Methods of Observational Astronomy	6	NUM	26
11-ASP-Int-201-m01	Introduction to Space Physics	6	NUM	27
11-EXZ5-Int-201-m01	Nontechnical Special Topics	5	NUM	45
11-EXZ6-Int-201-m01	Nontechnical Special Topics	6	NUM	46
11-EXNT6-Int-201-m01	Nontechnical Minor Subject	6	NUM	39
Master Project Modules (6	o ECTS credits)			
11-FS-N-Int-201-m01	Professional Specialization Quantum Engineering	15	B/NB	53
11-MP-N-Int-201-m01	Scientific Methods and Project Management Quantum Engi- neering	15	B/NB	59
11-MA-N-Int-201-m01	Master Thesis Quantum Engineering	30	NUM	58

Module	e title				Abbreviation	
Environ	nmenta	l Law			02-N-Ö-W2-05-152-m01	
Module	e coord	inator		Module offered by		
Dean o	fStudie	es Faculty of Law		Faculty of Law		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
3	numei	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate	Prior completion of	he following module	e is recommended: 02-N-Ö-V	
Conten	ts					
Germar	n conte	nts available but not tran	slated yet.			
Gegens der EU. verschi besond der bei	stand d Neben iedener lere der den Re	er Vorlesung sind sowoh den Grundzügen, den al Handlungsinstrumenter FEinfluss des europäisch chtsordnungen behandel	l das allgemeine als a Igemeinen Prinzipier 1 des Umweltrechts a en Umweltrechts auf 1 werden.	auch das besondere , der verfassungsred uf deutscher wie au das deutsche Umwe	Umweltrecht in Deutschland und chtlichen Verortung sowie den f europäischer Ebene sollen ins- eltrecht und das Zusammenspiel	
Intende	ed learr	ning outcomes				
Germar	n intend	ded learning outcomes av	vailable but not trans	lated yet.		
Die Stu lichen r sen Gru weltrec deutsch gesetzt	idierend rechtlic undzüge hts zu v he Rech	den haben einen umfasso hen Bestimmungen des o e, allgemeine Prinzipien, verorten und haben sich ntsordnung und das Zusa	enden Überblick über deutschen wie auch o verfassungsrechtlich darüber hinaus mit d mmenspiel der beide	r die Entwicklung, di des europäischen Ur ie Vorgaben und Har em Einfluss des euro en Rechtsordnungen	e Systematik und die wesent- nweltrechts erhalten. Sie wis- ndlungsinstrumente des Um- opäischen Umweltrechts auf die im diesem Bereich auseinander-	
Course	s (type,	number of weekly conta	ct hours, language —	if other than Germa	n)	
V (2)						
Methoo ster. in	d of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
a) writt	en exar	nination (approx. 120 mi	nutes) or b) oral exar	nination (approx. 15	minutes)	
Allocat	ion of r		years, white semest			
Allocal		naces				
 Additio	nal inf	ormation				
Auditio	matmit					
Worklo	ad					
oo h						
Teachir		<u> </u>				
reactin	is cycu	-				
Referre	d to in	IPOI (examination regu	lations for teaching.	legree programmes)		
Kelene						
Module	annea	rs in				
Bachel	or's deg	gree (1 major, 1 minor) Pu	blic Law (Minor, 201	5)		
Bachel	or's deg	gree (1 major, 1 minor) Pu	blic Law (Minor, 201	7)		
Bachel	or's de	gree (1 major, 1 minor) Pu	blic Law (Minor, 201	9)		
Master	's degre	ee (1 major) Quantum Eng	gineering (2020)			
Master	's degre	ee (1 major) Quantum Eng	gineering (2024)			

Modul	e title				Abbreviation	
Electrochemical Energy Storage and Conversion					08-FU-EEW-222-m01	
Modul	e coord	inator		Module offered by		
holder thesis	of the (Chair of Chemical Techno	logy of Material Syn-	Chair of Chemical To	echnology of Material Synthesis	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	nume	rical grade				
Durati	on	Module level	Other prerequisites			
1 seme	ester	undergraduate				
Conter	nts					
Chemi nickel layer c GaAs,	stry and metal h apacito organic	l application of battery sy ydride, sodium sulfur, so rs, redox-flow battery, fu and dye solar cell), therr	vstems (aqueous and odium nickel chloride el cell systems (AFC, l noelectric devices.	non-aqueous syster , lithium ion accumu PEMFC, DMFC, PAFC,	ns like lead, nickel cadmium and lators), electrochemical double SOFC), Solar cells (Si, CIS, CIGS,	
Intend	ed learr	ning outcomes				
The stu and ar	udents ៖ e able te	gain comprehensive know o apply this to scientific p	wledge in the field of problems.	electrochemical ene	rgy storage and transformation	
Course	es (type,	, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (2) + Modul	S (2) e taugh	t in: German or English				
Metho ster, in	d of ass Iformati	e ssment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
a) writh b) talk Langua Assess	ten exar (appro) age of a sment o	nination (approx. 90 min <. 30 minutes); (weighted ssessment: German and, ffered: Once a year, sumi	utes) or oral examina l 65:35) /or English mer semester	ation of one candidat	te each (approx. 30 minutes) and	
Alloca	tion of p	olaces				
Additio	onal info	ormation				
Worklo	ad					
150 h						
Teachi	ng cycl	9				
Referre	ed to in	LPO I (examination regu	lations for teaching-o	legree programmes)		
Modul	e appea	irs in				
Master	's degre	ee (1 major) Functional M	aterials (2022)			
Master	r's degre	ee (1 major) Quantum Eng	gineering (2024)			
Master	Naster's degree (1 major) Physics International (2024)					

Module title					Abbreviation		
Structure-Properties Correlations of Light Materials - Experiments and Num				iments and Numeri-	08-FU-MW-222-m01		
cal Sim	nulatior	15					
Module	e coord	inator		Module offered by			
degree tional I	progra Natrieri	mme coordinator Funktic als)	nswerkstoffe (Func-	Chair of Chemical T	echnology of Material Synthesis		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
5	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	Its						
Materia	al prope	erties of metals and cerar	nics: Structur-proper	ty relationships thro	ugh experiments and simulation.		
Intend	ed lear	ning outcomes					
The stu and hig sented sized.	idents g gh perfo . The re	gain fundamental knowle ormance ceramics. Analy Plationship of mikro- and	dge about the prope tical methods and pre nanoscopic structure	rties of modern mate edictions through nu of materials and the	erials: aviation aluminum alloys merical simulations will be pre- e resulting properties are empha-		
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
V (2) + Module	S (2) e taugh	t in: German or English					
Metho ster, in	d of ass formati	sessment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
a) writt b) talk Langua Assess	en exa (approz age of a ment o	mination (approx. 90 min x. 30 minutes); (weightec ssessment: German and, ffered: Once a year, sum	utes) or oral examina 60:40) /or English ner semester	ation of one candida	te each (approx. 30 minutes) and		
Allocat	ion of p	olaces					
Additio	onal inf	ormation					
Worklo	ad						
150 h							
Teachi	ng cycl	e					
Referre	ed to in	LPOI (examination regu	lations for teaching-c	legree programmes)			
Module	e appea	ars in					
Master	's degr	ee (1 major) Functional M	aterials (2022)				
Master	's degr	ee (1 major) Quantum En	gineering (2024)				
Master	Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation		
Sensor and Actor Materials - Functional Ceramics and Magnetic Particles					08-FU-SAM-161-m01		
Module	coord	inator		Module offered by			
degree tional N	progra Aatrieri	mme coordinator Funktio als)	nswerkstoffe (Func-	Chair of Chemical T	echnology of Material Synthesis		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
5	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
Fabrica materia	tion, ef Ils and	fects and applications of magnetostrictive materia	sensory and actuato als. Electrorheologica	ory materials such as l and magnetorheolo	piezoelectrics, shape memory ogical fluids, magnetofluids.		
Intende	ed learn	ning outcomes					
Studen	ts have	e developed fundamental	knowledge in the are	ea of sensory and ac	tuatory materials.		
Course	s (type	, number of weekly conta	ct hours, language —	· if other than Germa	n)		
V (2) +	P (2)				-		
Methoo ster, inf	l of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
Assessi Langua P: credi	ment o ge of a table f	ffered: Once a year, sum ssessment: German and/ or bonus	/or English				
Allocal		Jaces					
Additio	nalinf	ormation					
Auditio	natini						
	- d						
WOIKIO	au						
150 m		-					
Teachir	ig cycl	e					
Referre	a to in	LPOI (examination regu	lations for teaching-c	legree programmes)			
		•					
Module	appea						
Master'	s degre	ee (1 major) Physics (2010 20 (1 major) Nanostructur	b) za Tachnalagy (2016)				
Master'	s degre	ee (1 major) Nanostructur	aterials (2016)				
Master's degree (1 major) Nanostructure Technology (2020)							
Master'	Master's degree (1 major) Physics (2020)						
Master'	s degre	ee (1 major) Physics Inter	national (2020)				
Master'	s degre	ee (1 major) Quantum Eng	gineering (2020)				
Master'	s degre	ee (1 major) Quantum Tec	chnology (2021)				
Master Master	s degre	ee (1 major) Quantum Eng ee (1 major) Physics Inter	national (2024)				
musici	Master's degree (1 major) Physics International (2024)						

Module title				Abbreviation		
Ultrafast spectroscopy and quantum-control 08-PCM4-161-m01						
Modul	e coordinator		Module offered by	I		
lecture	er of the seminar "Nanoskali	ge Materialien"	Institute of Physica	l and Theoretical Ch	emistrv	
ECTS	Method of grading	Only after succ. cor	npl. of module(s)		,,	
5	numerical grade		<u> </u>			
Duratio	n Module level	Other prerequisites				
1 seme	ester graduate	Prior completion of	modules o8-PCM1a	and o8-PCM1b recon	nmended.	
Conter	nts	· ·				
This m laser p	odule discusses advanced t ulses, time-resolved laser s	opics in ultrafast spectro pectroscopy and coherer	oscopy and quantum nt control.	control. It focuses o	n ultrashort	
Intend	ed learning outcomes	· · · ·				
Studer	nts are able to describe the	generation of ultrashort l	aser pulses and to ch	aracterise them. The	ev can ex-	
plain tl princip	he theory of time-resolved la bles and applications of qua	aser spectroscopy and na ntum control.	ame experimental me	ethods. They can des	cribe the	
Course	es (type, number of weekly o	ontact hours, language -	– if other than Germa	ın)		
S (2) +	Ü (1)	- h				
Modul	e taught in: German or Engli	snif a th an th	··· C ·····	4:		
ster, in	d of assessment (type, scop formation on whether modu	le, language — if other th	i a bonus)	ition offered — if not	every seme-	
a) writt	ten examination (approx. 90	minutes) or b) oral exan	nination of one candi	date each (approx. 2	20 minutes)	
or c) ta	llk (approx. 30 minutes)					
Langua	age of assessment: German	and/or English				
Allocat	tion of places					
Additio	onal information					
Worklo	bad					
150 h	,					
Teachi	ng cycle					
Referre	ed to in LPO I (examination	regulations for teaching-	degree programmes)			
Modul	o appoars in					
Mostor	e appears III	m (()				
Master	r's degree (1 major) Chemist r's degree (1 major) Mathem	(2016)				
Master	's degree (1 major) Mathem	(2016)				
Master	r's degree (1 major) Physics	(2010) Icture Technology (2016)				
Master	r's degree (1 major) (Comput	ational Mathematics (201	(6)			
Master's teaching degree Gymnasium MINT Teacher Education PLUS Elite Network Bavaria (ENR) (2016)						
Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016)						
Master	Master's degree (1 major) Chemistry (2018)					
Master	Master's degree (1 major) Computational Mathematics (2019)					
Master	Master's degree (1 major) Mathematics (2019)					
Master	r's degree (1 major) Nanostr	ucture Technology (2020))			
Master	's degree (1 major) Physics	(2020)				
Master	's teaching degree Gymnas	um MINT Teacher Educat	tion PLUS, Elite Netw	ork Bavaria (ENB) (2	020)	
Master's w	ith 1 major Quantum Engineering (2024) JMU Würzburg ta record Maste	• generated 02-Apr-2024 • exer (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 11 / 86	

Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Technology (2021) Master's degree (1 major) Computational Mathematics (2022) Master's degree (1 major) Functional Materials (2022) Master's degree (1 major) Mathematics (2022) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Computational Mathematics (2022) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Computational Mathematics (2024)

Modul	e title				Abbreviation	
Databases 10-I=DB-161-m01					10-I=DB-161-m01	
Module coordinator Module offered				Module offered by	<u> </u>	
Dean	of Studie	es Informatik (Computer)	Science)	Institute of Comput	er Science	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
5	nume	rical grade				
Durati	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conte	nts		L			
Relatio transa	onal algo ction m	ebra and complex SQL st anagement.	atements; database	planning and norma	l forms, XML data modelling;	
Intend	ed learr	ning outcomes				
The stu data m	udents p nodellin	oossess knowledge abou g in XML.	it data modelling and	l queries in SQL, trar	sactions as well as about easy	
Course	es (type	number of weekly conta	ct hours. language –	- if other than Germa	in)	
V (2) +	Ü (2)				,	
Metho ster, ir	d of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
If anno examin prox. 1 Separa Langua	ounced l nation o 5 minut ate writt age of a able for	by the lecturer at the beg f one candidate each (ap es per candidate). en examination for Maste ssessment: German and, bonus	inning of the course, oprox. 20 minutes) or er's students. /or English	the written examination	tion may be replaced by an oral a in groups of 2 candidates (ap-	
Alloca	tion of p	laces				
Additi	onal info	ormation				
Focuse IS, HCI	es availa , GE.	able for students of the M	laster's programme l	nformatik (Compute	r Science, 120 ECTS credits): SE,	
Workle	oad					
150 h						
Teachi	ing cycl	e				
Referr	ed to in	LPOI (examination regu	lations for teaching-	degree programmes)		
		~	¥_			
Modul	e appea	rs in				
Maste	r's degre	ee (1 major) Computer Sc	ience (2016)			
Maste	Master's degree (1 major) Physics (2016)					
Master's degree (1 major) Digital Humanities (2016)						
Maste	Master's degree (1 major) Computer Science (2017)					
Maste	Master's degree (1 major) Computer Science (2018)					
Maste	i s uegre r's dear	ee (1 major) Physics (202 20 (1 major) Physics Intor	o) national (2020)			
Maste	r's degr	e (1 major) Ouantum Fro	gineering (2020)			
Maste	r's degre	ee (1 major) Quantum En	gineering (2024)			
Maste	r's degre	ee (1 major) Physics Inter	national (2024)			
·					~	

Modul	e title	Abbreviation				
Artific	ial Intelligence 1	10-l=Kl1-212-m01				
Modul	e coordinator		Module offered by			
holdor	r of the Chair of Computer Scien		Institute of Comput	or Science		
FCTS	Mathad of grading					
	numerical grade					
5 Durati						
Durati	on Module level	Other prerequisites	•			
Conte						
Intellie	rant agants uninformed and h		aint problem colving	coarch with partial	information	
propos	sitional and predicate logic and	<u>inference</u> , knowledge	e representation.	, search with partial	information,	
Intend	led learning outcomes					
The st search	udents possess theoretical and and logic and are able to asse	l practical knowledge ess possible applicatio	about artificial intelli ns.	gence in the area of	agents,	
Course	es (type, number of weekly con	tact hours, language –	- if other than Germa	n)		
V(2) +)		
Motho	d of assessment (type, scope,	if other th	an Corman, oxamina	tion offered — if not	ovory como-	
ster, ir	nformation on whether module	can be chosen to earn	a bonus)		every senie-	
lf anno exami prox. 1 credita Langu	bunced by the lecturer at the be nation of one candidate each (5 minutes per candidate). able for bonus age of assessment: German an	eginning of the course, approx. 20 minutes) of d/or English	the written examina an oral examinatior	tion may be replaced in groups of 2 cand	d by an oral idates (ap-	
Alloca	tion of places					
Additi	onal information					
Focuse AT,SE,	es available for students of the KI,HCI	Master's programme l	nformatik (Compute	r Science, 120 ECTS (credits):	
Workl	oad					
150 h						
Teach	ing cvcle					
Referr	ed to in LPO I (examination reg		degree programmes)			
			<u></u>			
Modul	e annears in					
Macto	r's dogroo (1 major) Computer (Science (2021)				
Maste	r's degree (1 major) Computer .	Computer Science (20	21)			
Maste	r's degree (1 major) Computati	anal Mathematics (20	21) 22)			
Maste	Master's degree (1 major) Computational Mathematics (2022) Master's degree (1 major) Information Systems (2022)					
Master's degree (1 major) Mathematics (2022)						
Maste	Master's degree (1 major) Computer Science (2023)					
Maste	r's degree (1 major) Aerospace	Computer Science (20	23)			
Master's degree (1 major) Quantum Engineering (2024)						
Maste	r's degree (1 major) Physics Int	ernational (2024)				
Maste	r's degree (1 major) Computatio	onal Mathematics (202	24)			
Maste	r's degree (1 major) Mathemati	cs (2024)				
Master's v	vith 1 major Quantum Engineering (2024)	JMU Würzburg • ta record Maste	e generated 02-Apr-2024 • ex r (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 14 / 86	



Master's degree (1 major) Information Systems (2024)

Module title					Abbreviation		
Quantum Communications 10-I=QC-221-m01					10-l=QC-221-m01		
Module coordinator				Module offered by			
holder	of the Chair of Co	mputer Scienc	e VII	Institute of Comput	er Science		
ECTS	Method of gradi	ng	Only after succ. con	npl. of module(s)			
5	numerical grade	!					
Duratio	on Module le	evel	Other prerequisites				
1 seme	ester graduate						
Conter	nts						
• • • () • () • () • () • () • () • () • ()	 Introduction Hilbert Spaces and Operators Quantum Mechanics Quantum States Quantum Circuit Elements Entanglement and Its Applications Quantum Key Distribution Quantum Channel Quantum Error Correction Coding Continuous-Variable Quantum Communications 						
Intend	ed learning outco	mes					
• (• [• [• [• [• [• [• [• [glement, and quar earn about secure Distribution (QKD) gain familiarity wit and understand the ef nitigate their impa	the protocols sufficient of the protocols of noise act.	nents, ons using quantum ich as quantum telep and decoherence in	mechanics, including portation, superdens quantum communic	g protocols like Quantum Key e coding and error correction, ations and learn strategies to		
V(2) +	V(2)	n weekiy conta			11)		
Modul	e taught in: Englis	h					
Metho ster, in	d of assessment (formation on whe	(type, scope, la ether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
written If anno examir prox. 1 Langua credita	written examination (approx. 60 to 120 minutes). If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (ap- prox. 15 minutes per candidate). Language of assessment: English creditable for bonus						
Allocat	tion of places						
Additio	Additional information						
Focuse	es available for stu	udents of the N	laster's programme li	nformatik (Computer	r Science, 120 ECTS credits): LR		
Worklo	bad				. ,		
150 h							
Teachi	ng cycle						
	0 - ,						
L							

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

Module appears in

Master's degree (1 major) Computer Science (2021) Master's degree (1 major) Computer Science (2023) Master's degree (1 major) Aerospace Computer Science (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Computational Mathematics (2024) Master's degree (1 major) Mathematics (2024)

Module title					Abbreviation		
Advand	ced Pro	gramming			10-I-APR-172-m01		
Module coordinator Module offered by							
holdor	oftho	Thair of Computer Science		Institute of Computer Science			
FCTS	Mothe	d of grading		ni strute of Comput			
	numo	rical grado	Only aller succ. con				
5	Inume						
Duratio	on	Module level	Other prerequisites				
1 Seine	ster	undergraduate	_				
Conten							
With th	e know	ledge of basic program	ning, taught in introdi	uctory lectures, it is p	oossible to realize si	mpler pro-	
grams.	de dun	licates occur. In this lect	ure further knowledg	re is to be conveyed (n how to give progr	rams and co-	
de a se	ensible	structure. Also, further to	opics in the areas of s	oftware security and	parallel programmi	ng are dis-	
cussed	l.		•	,		0	
Intend	ed learr	ning outcomes					
Studer	nts learr	n advanced programming	g paradigms especial	ly suited for space ap	oplications. Differen	t patterns are	
then in	npleme	nted in multiple languag	ges and their efficienc	y measured using sta	andard metrics. In a	ddition, par-	
allel pr	ocessir	ig concepts are introduc	ed culminating in the	use of GPU architect	tures for extremely q	luick proces-	
Sing.	e (turn o	number of weekly cont		if ather than Cormo	n)		
Course		, number of weekly conta	act nours, language –	- if other than Germa	in)		
V (2) +	0(2)	. (
ster, in	d of ass formati	on on whether module c	anguage — if other the chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-	
written	examir	nation (approx. 60 to 120	o minutes).				
lf anno	unced l	by the lecturer at the beg	ginning of the course,	the written examina	tion may be replace	d by an oral	
examir	nation o	f one candidate each (a	pprox. 20 minutes) or	an oral examination	in groups of 2 cand	idates (ap-	
prox. 1	5 minut	es per candidate). ssessment: German and	/or English				
credita	ble for	bonus					
Allocat	ion of r	places					
			_				
م با با به ام	nal inf						
Additio	matim						
			_				
workid	au						
150 n							
Teachi	ng cycl	e					
Referre	ed to in	LPO I (examination reg	ulations for teaching-	degree programmes)			
Modul	0 20002	rc in					
Rachol	e appea	raa (1 majar) Computar 9	Science (2017)				
Bachelor' degree (1 major) Computer Science (2017) Bachelor' degree (1 major) Computer Science (2017)							
Module	e studie	es (Bachelor) Computer 9	Science (2019)				
Master's degree (1 major) Nanostructure Technology (2020)							
Master	Master's degree (1 major) Physics (2020)						
Master	's teach	ning degree Gymnasium	MINT Teacher Educat	ion PLUS, Elite Netwo	ork Bavaria (ENB) (2	020)	
Supple	ementar	y course MINT Teacher E	ducation PLUS, Elite	Network Bavaria (EN	B) (2020)		
Bachel	or' deg	ree (1 major) Business Ir	formation Systems (2	2020)			
Master's w	ith 1 major	Quantum Engineering (2024)	JMU Würzburg ● ta record Master	generated 02-Apr-2024 • exa (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 18 / 86	

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Bachelor' degree (1 major) Computer Science und Sustainability (2021) Master's degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Business Information Systems (2021) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2022) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2023) Bachelor' degree (1 major) Business Information Systems (2023) Bachelor' degree (1 major) Business Information Systems (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2023)

Module title Abbreviation						
Operating Systems 10-I-BS-191-m01						
Module coordinator Module offered by						
holder	of the (Chair of Computer Scien	ce ll	Institute of Comput	er Science	
ECTS Method of grading Only after succ. compl. of module(s)						
5	nume	rical grade		•		
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate				
Conten	Contents					
Introdu sing in ry man	iction to operati agemer	o computer systems, de ng systems, processes nt, device and file mana	velopment of operatir and threads, CPU sch gement, operating sys	ig systems, architect eduling, synchronisa stem virtualisation.	ure principles, interr ition and communica	upt proces- ation, memo-
Intend	ed learr	ning outcomes				
The stu	ıdents p	possess knowledge and	practical skills in bui	ding and using esse	ntial parts of operati	ing systems.
Course	s (type	number of weekly cont	act hours, language –	- if other than Germa	n)	
V (2) + Module	Ü (2) e taugh	t in: English				
Metho ster, in	d of ass formati	essment (type, scope, on on whether module	language — if other th can be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-
If anno examir prox. 19 Langua credita	examir unced l nation o 5 minut age of a ble for	nation (approx. 60 to 12 by the lecturer at the be f one candidate each (a es per candidate). ssessment: German and bonus	o minutes). ginning of the course, approx. 20 minutes) or d/or English	the written examina an oral examination	tion may be replaced in groups of 2 cand	d by an oral idates (ap-
Allocat	ion of r	olaces				
	· · · ·					
Additio	onal info	ormation				
Workle						
WOIKIO	au					
150 h						
Teachi	ng cycl	9				
Referre	ed to in	LPOI (examination reg	ulations for teaching-	degree programmes)		
Module	e appea	rs in				
Bachel	or' deg	ree (1 major) Computer	Science (2019)			
Master	's degre	ee (1 major) Nanostructi	ure Technology (2020)			
Master's degree (1 major) Physics (2020)						
Bachelor' degree (1 major) Business Information Systems (2020)						
Master's degree (1 major) Physics International (2020)						
Master's degree (1 major) Quantum Engineering (2020)						
Bachel	or' degi	ree (1 major) Aerospace	Computer Science (20)20)		
Bachel	or degi	ree (1 major) Computer	Science und Sustainal	DIIITY (2021)		
waster	s aegre	ee (1 major) Quantum 16	echnology (2021)	2221)		
Bachel	or degi	ee (1 major) Business I (1 major) Artificial In	telligence and Data S	(2021)		
Bachel	ucgi		Lettigence and Data S			
Master's w	ith 1 major	Quantum Engineering (2024)	JMU Würzburg • ta record Maste	generated 02-Apr-2024 • exa r (120 ECTS) Quantum Engined	am. reg. da- ering - 2024	page 20 / 86

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Bachelor' degree (1 major) Artificial Intelligence and Data Science (2023) Bachelor' degree (1 major) Mathematics (2023) Bachelor' degree (1 major) Business Information Systems (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2024)

Module title			Abbreviation			
Discrete Mathematics				10-M=VDIMin-152-m01		
Module	e coord	inator		Module offered by		
Dean of	f Studie	es Mathematik (Mathema	atics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Advanc graph t	ed met heory c	hods and results in a sel or combinatorics)	ected field of discrete	e mathematics (e.g.	coding theory, cryptography,	
Intende	ed learr	ning outcomes				
The stu	dent is	acquainted with advanc	ed results in a selecte	ed topic in discrete r	nathematics.	
Course	s (type,	, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (3) + l Module	Ü (1) e taugh	t in: English				
Methoo ster, inf	l of ass formati	e ssment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
(approx Assess Langua credital	en exa k. 15 mi ment o ge of a ble for	nutes) or c) oral examina ffered: In the semester in ssessment: English bonus	tion in groups (group which the course is	offered and in the su	inutes per candidate) Ibsequent semester	
Allocat	ion of p	olaces				
Additio	nal info	ormation				
Worklo	ad					
150 h						
Teachir	ng cycl	9				
Referre	d to in	LPO I (examination regu	lations for teaching-c	legree programmes)		
Module appears in						
Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)						

Module title			Abbreviation		
Advanced Analysis			10-M-VAN-222-m01		
Module	e coord	inator		Module offered by	
Dean of	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	atics
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	ts				
Continu rems.	uation	of analysis in several vari	ables; Lebesgue mea	sure and Lebesgue	integral in R^n, integral theo-
Intende	ed lear	ning outcomes			
The stu she is a	dent is able to	acquainted with advanc understand the construct	ed topics in analysis. tion of a complex mat	Taking the example thematical concept	of the Lesbegue integral, he or
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)
V (4) +	Ü (2)				
Methoo ster, inf	l of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
a) writte b) oral c) oral e Langua credital	en exai examir examin ge of a ble for	nination (approx. 90 to 1 ation of one candidate e ation in groups (groups c ssessment: German and, bonus	80 minutes, usually o ach (15 to 30 minutes of 2, 10 to 15 minutes or English	chosen) or 6) or per candidate)	
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
300 h					
Teachir	ıg cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	Module appears in				
Bachel	Bachelor' degree (1 major) Mathematical Data Science (2022)				
exchan	ge prog	gram Mathematics (2023))	,	
Master	's degr	ee (1 major) Quantum Eng	gineering (2024)		
Master	's degr	ee (1 major) Physics Inter	national (2024)		

Module title				Abbreviation		
Selected Topics of Theoretical Solid State Physics				11-AKTF-Int-201-m01		
Module	coord	inator		Module offered by		
Managi and Ast	ng Dire trophys	ector of the Institute of Th sics	eoretical 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	graduate				
Conten	ts					
In this l ments t and dyr	ecture, o bring namic c	, selected topics of conde g the students in touch w quantum matter.	ensed matter theory a ith actual research to	are addressed. We in pics. Possible subje	tend to present new develop- cts are many-body localization	
Intende	ed learr	ning outcomes				
The stu theoret a smoo	dents l ical po th cros	earn how to describe cor int of view. This happens sover of these students t	idensed matter syste on the basis of analy o the next step of be	ms in presence of di ytical and numerical coming a researcher	sorder and interactions from a methods. Therefore, we envisage	
Courses	s (type,	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + I Module	R (1) e taugh	t in: English				
Methoo ster, inf	l of ass formati	s essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
nutes) of prox. 8 If a writ stead ta of asse nation of Assessi Langua	to 10 p to 10 p ten exa ake the ssment date at ment o ge of a	al examination (approx. 96 to 1 al examination in groups bages) or e) presentation/ amination was chosen as form of an oral examinat t is changed, the lecturer the latest. ffered: In the semester in ssessment: English	(groups of 2, approx (talk (approx. 30 min method of assessme tion of one candidate must inform student which the course is	a examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four offered and in the su	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of r	laces				
		hates				
Additio	nal info	ormation				
Worklo	ad					
180 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	appea	ins in				
Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)						

Module title				Abbreviation		
Astrophysics					11-AP-Int-201-m01	
Module	coord	inator		Module offered by		
Managi and Ast	ng Dire rophys	ector of the Institute of Th ics	eoretical 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 semes	ster	undergraduate				
Conten	ts					
History Telesco Medium tive Gal	of Astr pes an 1, Mole actic N	onomy, Coordinates and d Detectors, Stellar Struc cular Clouds, Structure o uclei, Large-Scale Structu	Time Measurement, ture and Atmospher f the Milky Way, the ures, Cosmology.	the Solar System, Ex es, Stellar Evolution Local Universe, the E	oplanets, Astronomical Scales, and their End Stages, Interstellar Expanding Universe, Galaxies, Ac-	
Intende	d lear	ning outcomes				
The stur of astro the phy	dent is physic sics ar	familiar with the moderr al research. He/She is ab ad evolution of the most i	astrophysical world ble to plan and interp mportant astrophysi	view. He/She knows ret his/her own obse cal objects, e.g., star	s the methods and instruments ervations. He/She is familiar with 's and galaxies.	
Courses	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (2) + F Module	R (2) taugh	t in: English				
Method ster, inf	l of ass ormati	e ssment (type, scope, la on on whether module ca	nguage — if other than be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
a) writte nutes) o prox. 8 If a writ stead ta of asses nation o Assessi Langua	en exar for c) or to 10 p ten exa ake the ssment date at ment o ge of a	nination (approx. 90 to 1 al examination in groups ages) or e) presentation/ amination was chosen as form of an oral examina- t is changed, the lecturer the latest. ffered: In the semester in ssessment: English	20 minutes) or b) ora (groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate must inform student which the course is	Il examination of one . 30 minutes per can utes). ent, this may be char e each or an oral exan s about this by four v offered and in the su	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- ubsequent semester	
Allocati	ion of p	olaces				
Additio	nal info	ormation				
Worklo	ad					
180 h	180 h					
Teaching cycle						
Referre	d to in	LPOI (examination regu	lations for teaching-o	degree programmes)		
Module	appea	in				
Master'	s degre	ee (1 major) Quantum Eng	gineering (2020)			
exchan	ge prog	gram Physics (2023)				
Master'	Master's degree (1 major) Quantum Engineering (2024)					

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Module title					Abbreviation	
Methoo	Methods of Observational Astronomy 11-ASM-Int-201-m01					
Module	e coord	inator		Module offered by		
Managi and As	ing Dire trophys	ector of the Institute of Th sics	eoretical 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	graduate				
Conten	ts					
Methoo tional o	ls of ot lata fro	oservational Astronomy a m radio, optical, X-ray ar	cross the electromag	metic spectrum; Extr	action and reduction of observa-	
Intende	ed learı	ning outcomes				
Overvie (radio, ability t	ew over optical to cond	the methods used in ob , X-ray and gamma-ray er luct astronomical observa	servational astronom nergies). Knowledge ations.	ly in various parts of of principles and app	the electromagnetic spectrum blications of these methods and	
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + Module	R (1) e taugh	t in: English				
Methoo ster, in	d of ass formati	sessment (type, scope, la on on whether module ca	nguage — if other than be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
prox. 8 If a writ stead t of asse nation Assess Langua	to 10 p ten exa ake the ssmen date at ment o ge of a	ar examination in groups pages) or e) presentation, amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ffered: In the semester in ssessment: English	(groups of 2, approx /talk (approx. 30 min method of assessme tion of one candidate must inform student which the course is	and the server of the server o	nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	's degr	ee (1 major) Physics Inter	national (2020)			
Master	's degr	ee (1 major) Quantum En	gineering (2020)			
exchan	ge prog	gram Physics (2023)				
Master	's degr	ee (1 major) Quantum Eng	gineering (2024)			
Master	s degr	Master's degree (1 major) Physics International (2024)				

Module title			Abbreviation				
Introduction to Space Physics 11-ASP-Int-201-m01							
Module coordinator Module offered by							
Manag and As	ing Dire trophys	ector of the Institute of T Sics	heoretical Physics	Faculty of Physics a	nd Astronomy		
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)			
6	6 numerical grade						
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	its		_				
1. Over 2. Dyna 3. Elem 4. The 5. Acce 6. Instr	view amics o nents o sun and eleratio ruments	f charged particles in m f space physics d heliosphere n and transport of energ s to measure energetic p	agnetic and electric fi etic particles in the he particles in extraterres	elds eliosphere trial space			
Intend	ed lear	ning outcomes					
Basic k space a their m	knowled and the leasure	lge in space physics, in heliosphere. Knowledg ments.	particular of the chara e of the relevant para	acterzation of the dyn meters, the theoretic	namics of charged pa al concepts and the	articles in methods of	
Course	s (type	, number of weekly cont	act hours, language –	- if other than Germa	n)		
V (3) + Module	R (1) e taugh	t in: English					
Metho ster, in	d of as format	sessment (type, scope, l ion on whether module o	anguage — if other the can be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-	
a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua	en exa or c) or to 10 p tten exa ake the essmen date at ment o age of a	mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examina- t is changed, the lecture the latest. ffered: In the semester i ssessment: English	120 minutes) or b) ora s (groups of 2, approx n/talk (approx. 30 min s method of assessme ation of one candidate r must inform student n which the course is	al examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa is about this by four offered and in the su	e candidate each (ap didate) or d) project nged and assessmer mination in groups. I weeks prior to the or ubsequent semester	prox. 30 mi- report (ap- 1t may in- If the method riginal exami-	
Allocat	ion of	olaces					
Additio	onal inf	ormation					
Worklo	ad						
180 h							
Teaching cycle							
Referred to in LPO L (examination regulations for teaching-degree programmes)							
Module	 Module appears in						
Master's degree (1 major) Physics International (2020)							
Master	Master's degree (1 major) Quantum Engineering (2020)						
exchan	ige pro	gram Physics (2023)					
Master's w	ith 1 majo	r Quantum Engineering (2024)	JMU Würzburg • ta record Master	generated 02-Apr-2024 • exa r (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 27 / 86	



Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title				Abbreviation		
Image	Image and Signal Processing in Physics 11-BSV-Int-201-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	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	lts					
Periodi of the o rem, co graphy	ic and a digital s prrelations : Hanke	periodic signals; basic p ignal and image process on and energy considerat el and Radon transformat	rinciples of the discr ing; discretization of ion; statistical signal ion.	ete and exact Fourie signals/Shannon sa ls, image noise, mon	r transformation; basic principles impling theorem; Parsival theo- nents, stationary signals; tomo-	
Intend	ed learı	ning outcomes				
Advano proces cular o	ced kno sing an f applyi	wledge about digital ima d various methods of sig ng them to tomography.	ge and signal proces nal processing. Capa	sing. Familiarity with bility of describing t	n the physical principles of image he various methods and in parti-	
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (2) + Module	Ü (2) e taugh	t in: English				
Metho ster, in	d of ass formati	s essment (type, scope, la on on whether module ca	nguage — if other than an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
nutes) prox. 8 If a wri stead t of asse nation Assess Langua	or c) or to 10 p tten exa ake the essmen date at ment o age of a	al examination in groups bages) or e) presentation/ amination was chosen as form of an oral examina t is changed, the lecturer the latest. ffered: In the semester in ssessment: English	(groups of 2, approx /talk (approx. 30 min method of assessme tion of one candidate must inform student	a. 30 minutes per can utes). ent, this may be chan e each or an oral exa as about this by four offered and in the su	Indidate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master Master exchar Master	Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024)					
master	master's degree (1 major) Physics International (2024)					

Module title			Abbreviation			
Advanced Topics in Solid State Physics 11-CSFM					11-CSFM-Int-201-m01	
Module	e coord	inator		Module offered by		
Managi and Ast	ing Dire trophys	ector of the Institute of Th sics	eoretical 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	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
This mo vered in not incl	odule v n any o luded i	vill enable the lecturers o f the other modules. The n the regular curriculum.	f condensed matter p se topics may relate o	bhysics to teach adva either to recent resea	anced courses on topics not co- arch developments or to subjects	
Intende	ed lear	ning outcomes				
In-dept face be	h knov tween	vledge and understanding teaching and research.	g of an advanced top	ic in condensed mat	ter physics. Insight into the inter-	
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + Module	R (1) e taugh	t in: English				
Methoo ster, inf	l of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other than be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
nutes) prox. 8 If a writ stead ta of asse nation	en exa or c) or to 10 p ten exa ake the ssmen date at ge of a	al examination (approx. 90 to 1 al examination in groups bages) or e) presentation/ amination was chosen as e form of an oral examina- t is changed, the lecturer t the latest. ssessment: English	(groups of 2, approx (talk (approx. 30 min method of assessme tion of one candidate must inform student	a examination of one . 30 minutes per can utes). ent, this may be char e each or an oral exam s about this by four	didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of _l	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachir	ıg cycl	e				
Referre	d to in	LPOI (examination regu	lations for teaching-o	degree programmes)		
Module	e appea	ars in				
Master	's degr	ee (1 major) Physics Inter	national (2020)			
Master	's degr	ee (1 major) Quantum Eng	gineering (2020)			
Master	's degr	ee (1 major) Quantum Eng	gineering (2024)			
Master	Master's degree (1 major) Physics International (2024)					

Module title				Abbreviation	
Advanced Topics in Quantum Engineering			11-CSNM-Int-241-m01		
Module	e coord	inator		Module offered by	
Managi and As	ing Dire trophys	ector of the Institute of Th sics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)	
6	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired.
Conten	ts				
This mo that ca deal wi	odule a n not b th topi	llows lecturers of the Qua e covered by any other m cs that are not included i	antum Engineering st odule. These lecture n the regular teaching	udy programme to g s may either reflect n g cycle.	ive lectures on advanced topics new developments in research or
Intende	ed lear	ning outcomes			
The stu gaining	dents o insigh	deepen their knowledge a ts into the interface betw	and understanding of een research and tea	f an advanced topic i aching.	n Quantum Engineering, thereby
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)
V (3) + Module	R (1) e taugh	t in: English			
Method ster, in	d of ass formati	sessment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
a) writt b) oral c) oral d d) proje e) pres If a writ stead t of asse nation Langua	en exan examin examin ect repo entatio tten exa ake the ssmen date at ge of a	mination (approx. 90 to 1 nation of one candidate e ation in groups (groups c ort (approx. 8 to 10 pages n/talk (approx. 30 minut amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ssessment: English	20 minutes) or ach (approx. 30 minu of 2, approx. 30 minu o) or es). method of assessme tion of one candidate must inform student	ites) or tes per candidate) or ent, this may be char e each or an oral exar s about this by four v	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Workload					
180 h					
Teachi	ng cycl	e			
Referre	d to in	LPOI (examination regu	lations for teaching-o	legree programmes)	
Module	Module appears in				
Master	's degr	ee (1 major) Quantum Eng	gineering (2024)		

Module title	Abbreviation					
Advanced Topics in Physics 11-CSPM-Int-201-m01						
Module coordinator Module offered by						
chairperson of examination committee		Faculty of Physics a	nd Astronomy			
ECTS Method of grading	Only after succ. com	pl. of module(s)				
6 numerical grade						
Duration Module level	Other prerequisites					
1 semester graduate	Approval from exam	ination committee re	equired.			
Contents						
This module allows lecturers of the phy covered by any other module. These lead that are not included in the regular tead.	sics study programm ctures may either refl ching cycle.	e to give lectures on ect new developmer	advanced topics that can not be nts in research or deal with topics			
Intended learning outcomes						
The students deepen their knowledge a sights into the interface between resea	and understanding of rch and teaching.	an advanced topic i	in physics, thereby gaining in-			
Courses (type, number of weekly conta	ct hours, language —	if other than Germa	n)			
V (3) + R (1) Module taught in: English						
Method of assessment (type, scope, la ster, information on whether module ca	nguage — if other tha In be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-			
nutes) or c) oral examination (approx. 90 to 1, nutes) or c) oral examination in groups prox. 8 to 10 pages) or e) presentation/ If a written examination was chosen as stead take the form of an oral examinat of assessment is changed, the lecturer nation date at the latest. Language of assessment: English	(groups of 2, approx talk (approx. 30 min method of assessme ion of one candidate must inform student	a so minutes per can utes). ent, this may be char each or an oral exa s about this by four	didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-			
Allocation of places						
Additional information						
Workload						
180 h						
Teaching cycle						
Referred to in LPO I (examination regul	ations for teaching-c	legree programmes)				
Module appears in						
Master's degree (1 major) Quantum Eng	gineering (2020)					
Master's degree (1 major) Quantum Eng	gineering (2024)					

Module title			Abbreviation			
Electro	Electron and Ion Microscopy 11-EIM-Int-201-m01					
Module	e coord	inator		Module offered by		
Manag	ing Dire	ector of the Institute of Ap	plied 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	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	Its					
Theore trons a ced co	tical Fo nd cha ntrast n	undations. Electron and i rged particles, detectors, nechanisms: EBSD, EELS,	on sources, optics of measurement princi , EDS, cathodolumine	f charged particles, i ples: SEM, STEM, TE escence.	nteraction of matter with elec- M, sample preparation, advan-	
Intend	ed lear	ning outcomes				
The stu and ins electro	ident h strumer n micro	as specific and immersec ntal basics and principles pscopy and their applicati	l knowledge in electr of detectors and cor ions. He/she knows o	on and ion microsco ntrast mechanisms. I ongoing developmen	py. He/she knows the theoretical He/she knows different modi of Its in this field.	
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + Module	R (1) e taugh	t in: English				
Metho ster. in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
a) writt nutes) prox. 8 If a wri stead t of asse nation Langua	en exa or c) or to 10 p tten exa ake the essmen date at age of a	mination (approx. 90 to 1 al examination in groups bages) or e) presentation/ amination was chosen as e form of an oral examinat t is changed, the lecturer t the latest. ssessment: English	20 minutes) or b) ora (groups of 2, approx (talk (approx. 30 min method of assessme tion of one candidate must inform student	Il examination of one . 30 minutes per can utes). ent, this may be char e each or an oral exam s about this by four y	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-	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
Teaching cycle: annually, after announcement						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					
Master	's degr	ee (1 major) Physics Inter	national (2020)			
exchar	ige prog	gram Physics (2023)	/ 、			
Master	's degr	ee (1 major) Quantum Eng	gineering (2024)			
master	Master's degree (1 major) Physics International (2024)					

Module	e title		Abbreviation			
Current	Topics	s in Quantum Engineering	g		11-EXN5-Int-241-m01	
Module coordinator				Module offered by		
chairpe	erson of	f examination committee		Faculty of Physics and Astronomy		
ECTS	Metho	od of grading	Only after succ. compl. of module(s)			
5 numerical grade		rical grade				
Duratio	n	Module level	Other prerequisites			
1 semester graduate		Approval from examination committee required.				
Conten	ts					
Current univers	topics	in experimental or theor tudy abroad.	etical physics. Credite	ed academic achieve	ements, e.g. in case of change of	
Intende	ed learr	ning outcomes				
The student posseses advanced knowledge meeting the requirements of a module in theoretical or experimental physics on Master's level in the study programme Quantum Engineering. He/She commands knowledge in a current field in physics and insight into the measuring and calculating methods which are necessary to acquire this knowledge. He/She is able to classify and to link the learnt. He/She knows about fields of application.						
V (2) + I Module	R (2)	t in: English	, , , , , , , , , , , , , , , , , , , ,		,	
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)						
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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 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.						
Allocation of places						
Additional information						
Workload						
150 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master'	's degre	ee (1 major) Quantum Eng	gineering (2024)			

Module	title		Abbreviation				
Current	Topics	s in Quantum Engineering	g		11-EXN6A-Int-241-m01		
Module coordinator				Module offered by			
chairpe	rson o	f examination committee		Faculty of Physics and Astronomy			
ECTS	Metho	od of grading	Only after succ. compl. of module(s)				
6 numerical grade							
Duration		Module level	Other prerequisites				
1 semester graduate		Approval from examination committee required.					
Conten	ts						
Current univers	topics ity or s	in experimental or theor tudy abroad.	etical physics. Credite	ed academic achieve	ements, e.g. in case of change of		
Intende	ed learr	ning outcomes					
The student posseses advanced knowledge meeting the requirements of a module in theoretical or experimental physics on Master's level in the study programme Quantum Engineering. He/She commands knowledge in a current field in physics and insight into the measuring and calculating methods which are necessary to acquire this knowledge. He/She is able to classify and to link the learnt. He/She knows about fields of application.							
V (3) + I Module	R (1) e taugh	t in: English					
Method ster, inf	l of ass formati	e ssment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	in German, examina a bonus)	tion offered — if not every seme-		
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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 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.							
Allocation of places							
	•						
Additional information							
Workload							
180 h							
Teaching cycle							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appears in							
Master'	s degre	ee (1 major) Quantum Eng	gineering (2024)				
L							

Module	e title		Abbreviation				
Current	Topic	s in Quantum Engineering	g		11-EXN6-Int-241-m01		
Module coordinator				Module offered by			
chairperson of examination committee				Faculty of Physics and Astronomy			
ECTS Method of grading		Only after succ. compl. of module(s)					
6	5 numerical grade						
Duratio	n	Module level	Other prerequisites				
1 semester graduate		Approval from examination committee required.					
Conten	ts						
Current univers	topics	in experimental or theor tudy abroad	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of		
Intende	ed lear	ning outcomes	,				
The student posseses advanced knowledge meeting the requirements of a module in theoretical or experimental physics on Master's level in the study programme Quantum Engineering. He/She commands knowledge in a current field in physics and insight into the measuring and calculating methods which are necessary to acquire this knowledge. He/She is able to classify and to link the learnt. He/She knows about fields of application.							
V(3) +	R (1)						
Module	e taugh	t in: English					
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)							
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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 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.							
Allocat	ion of p	olaces					
Additional information							
Workload							
180 h							
Teaching cycle							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appears in							
Master	's degr	ee (1 major) Quantum Eng	gineering (2024)				
Module title			Abbreviation				
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Current Topics in Quantum Engineering				11-EXN7-Int-241-m01			
Module	coord	inator		Module offered by			
chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
7	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate	Approval from exam	ination committee re	equired.		
Conten	ts						
Current univers	topics ity or s	in experimental or theor tudy abroad.	etical physics. Credite	ed academic achieve	ements, e.g. in case of change of		
Intende	ed learr	ning outcomes					
physics rent fiel knowle	dent po on Ma ld in ph dge. He s (type.	sseses advanced knowl ster's level in the study p sysics and insight into the e/She is able to classify a number of weekly conta	orogramme Quantum e measuring and calc and to link the learnt. ct hours. language —	Engineering. He/She ulating methods wh He/She knows abou	e commands knowledge in a cur- ich are necessary to acquire this ut fields of application. n)		
V (3) + I Module	R (1)	t in• English			.,		
Method ster, inf	l of ass formati	e essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
a) writte nutes) o prox. 8 If a writ stead ta of asse nation o Langua	en exar or c) or to 10 p ten exa ake the ssment date at ge of a	nination (approx. 90 to 1 al examination in groups ages) or e) presentation/ amination was chosen as form of an oral examina t is changed, the lecturer the latest. ssessment: English	20 minutes) or b) ora (groups of 2, approx. (talk (approx. 30 minu method of assessme tion of one candidate must inform student.	l examination of one . 30 minutes per can utes). ent, this may be char each or an oral exan 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-		
Allocat	ion of r	laces					
Additio	nal info	ormation					
Worklo	ad						
210 h							
Teaching cycle							
Referre	d to in	LPOI (examination regu	lations for teaching-d	legree programmes)			
Module	Module appears in						
Master'	s degre	ee (1 major) Quantum Eng	gineering (2024)				

Module title			Abbreviation		
Current	t Topic	s in Quantum Engineerin	S		11-EXN8-Int-241-m01
Module	e coord	inator		Module offered by	
chairpe	erson o	f examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
8	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired
Conten	ts				
Current univers	topics	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of
Intende	ed lear	ning outcomes			
physics rent fie knowle	s on Ma ld in pl dge. Ho	aster's level in the study p nysics and insight into th e/She is able to classify a	orogramme Quantum e measuring and calc and to link the learnt.	Engineering. He/Sh ulating methods wh He/She knows abou	e commands knowledge in a cur- ich are necessary to acquire this ut fields of application.
V (4) +	R (2)		et nours, tanguage –	n other than Germa	1)
Module	e taugh	t in: English			
Method ster, in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
a) writt nutes) prox. 8 If a writ stead t of asse nation Langua	en exai or c) or to 10 p tten exa ake the ssmen date at ge of a	mination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ssessment: English	20 minutes) or b) ora (groups of 2, approx. (talk (approx. 30 minu- method of assessme tion of one candidate must inform student	l examination of one . 30 minutes per can utes). ent, this may be char e each or an oral exa 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-
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
240 h					
Teaching cycle					
Referre	d to in	LPOI (examination regu	lations for teaching-c	legree programmes)	
Module	Module appears in				
Master	's degr	ee (1 major) Quantum Eng	gineering (2024)		

Module title			Abbreviation			
Nontechnical Minor Subject					11-EXNT6-Int-201-m01	
Module	e coord	inator		Module offered by		
chairpe	erson of	examination committee		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 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Non-teo	chnical	minor. Crediting for acac	lemic achievements,	e.g. from university	change or study abroad	
Intende	ed learn	ning outcomes				
The stu of a no	dent po n physi	osseses advanced knowl cal minor subject (mathe	edge on Master's leve matics, chemistry, co	el meeting the requi omputer science, leg	rements of a module in the field al science, economics,).	
Course	s (type,	, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (3) + Module	R (1) e taugh	t in: English				
Methoo ster, in	d of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
nutes) prox. 8 If a writ stead ta of asse nation 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/ mination was chosen as form of an oral examina- t is changed, the lecturer the latest. ssessment: English	(groups of 2, approx. 'talk (approx. 30 minu method of assessme tion of one candidate must inform student	. 30 minutes per can utes). ent, this may be char each or an oral exa s about this by four y	didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	nal info	ormation				
Worklo	ad					
180 h						
Teachir	Teaching cycle					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	Module appears in					
Master	Master's degree (1 major) Quantum Engineering (2020)					
muster	Master's degree (1 major) Quantum Engineering (2024)					

Module title			Abbreviation			
Current Topics in Physics 11-EXP5-Int-201-m01				11-EXP5-Int-201-m01		
Module coordinator Module offered by						
chairpe	erson o	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Current univers	t topics sity or s	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achiev	ements, e.g. in case of change of	
Intend	ed lear	ning outcomes				
The stu physics a curre this kn	ident p s on Ma nt field owledg s (type	osseses advanced knowl aster's level in the study p in physics and insight in re. He/She is able to class number of weekly conta	edge meeting the rec programme Nanostruc to the measuring and sify and to link the lea ct hours. language —	juirements of a mod cture Technology. He l calculating method arnt. He/She knows if other than Germa	ule in theoretical or experimental e/She commands knowledge in Is which are necessary to acquire about fields of application. n)	
V (2) + Module	R (2) e taugh	t in: English			,	
Metho ster, in	d of ass formati	sessment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
a) writt nutes) prox. 8 If a writ stead t of asse nation Langua	en exal or c) or to 10 p tten exa ake the essmen date at age of a	mination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ssessment: English	20 minutes) or b) ora (groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate must inform student	l examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four	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-	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
150 h						
Teaching cycle						
Referre	Referred to in LPO L (examination regulations for teaching degree programmes)					
Module	e annea	urs in				
Master	's degr	ee (1 major) Quantum Eng	gineering (2020)			
Master	's degr	ee (1 major) Quantum En	gineering (2024)			

Modul	e title				Abbreviation
Curren	Current Topics in Physics 11-EXP6A-Int-201-mo1				
Module coordinator Module offered by					
chairp	erson o	f examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
6	nume	rical grade			
Durati	on	Module level	Other prerequisites		
1 seme	ester	graduate	Approval from exam	ination committee re	equired.
Conte	nts				
Curren univer	it topics sity or s	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of
Intend	ed lear	ning outcomes			
The stu physic a curre this kr	udent p s on Ma ent field nowledg	osseses advanced knowl aster's level in the study p in physics and insight in ge. He/She is able to class	edge meeting the rec programme Nanostru to the measuring and sify and to link the le	quirements of a mod cture Technology. He d calculating method arnt. He/She knows	ule in theoretical or experimental e/She commands knowledge in Is which are necessary to acquire about fields of application.
Course	es (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)
V (3) + Modul	R (1) e taugh	t in: English			
Metho ster, ir	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
nutes) prox. 8 If a wri stead i of asso nation Langua	or c) or or c) or to 10 p itten exa take the essmen date at age of a	al examination (approx. 90 to 1 al examination in groups bages) or e) presentation/ amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ssessment: English	(groups of 2, approx (talk (approx. 30 min method of assessme tion of one candidate must inform student	a examination of one . 30 minutes per can utes). ent, this may be char e each or an oral exa s about this by four	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Alloca	tion of p	olaces			
Additi	onal inf	ormation			
Workle	oad				
180 h					
Teachi	ing cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Modul	e appea	ars in			
Maste	r's degr	ee (1 major) Physics Inter	national (2020)		
Maste	r's degr	ee (1 major) Quantum Eng	gineering (2020)		
Maste	r's degr	ee (1 major) Quantum Eng	gineering (2024)		
Maste	r's degr	ee (1 major) Physics Inter	national (2024)		

Module title			Abbreviation		
Current	Current Topics in Physics 11-EXP6-Int-201-m01				
Module	e coord	inator		Module offered by	
chairpe	erson o	f examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
6	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired.
Conten	Its				
Current univers	t topics sity or s	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of
Intende	ed lear	ning outcomes			
The stu physics a curre this kn	ident p s on Ma nt field owledg	osseses advanced knowl aster's level in the study p in physics and insight in ge. He/She is able to class	edge meeting the rec programme Nanostru to the measuring and sify and to link the le	quirements of a mod cture Technology. He d calculating method arnt. He/She knows	ule in theoretical or experimental e/She commands knowledge in s which are necessary to acquire about fields of application.
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)
V (3) +	R (1)				
Method ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Langua Allocat Additio Uworklo	V (3) + R (1) Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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 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: English Allocation of places Moditional information Workload				
Teachi	ng cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in					
Master Master Master Master	's degr 's degr 's degr 's degr	ee (1 major) Physics Inter ee (1 major) Quantum Eng ee (1 major) Quantum Eng ee (1 major) Physics Inter	national (2020) gineering (2020) gineering (2024) national (2024)		

Module	e title				Abbreviation
Current Topics in Physics				11-EXP7-Int-201-m01	
Module	e coord	inator		Module offered by	
chairpe	erson o	f examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
7	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired.
Conten	ts				
Current univers	t topics ity or s	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of
Intende	ed lear	ning outcomes			
The stu physics a curren this kno	dent p s on Ma nt field owledg	osseses advanced knowl aster's level in the study p in physics and insight in ge. He/She is able to class	edge meeting the req programme Nanostruc to the measuring and sify and to link the lea	uirements of a mod cture Technology. He I calculating method arnt. He/She knows	ule in theoretical or experimental e/She commands knowledge in Is which are necessary to acquire about fields of application.
Course	s (type	, number of weekly conta	ct hours, language —	f other than Germa	n)
V (3) + Module	R (1) e taugh	t in: English			
Methoo ster, in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
a) writt b) oral c) oral o d) proje e) press If a writ stead ta of asse nation Langua	en exa examir examin ect repo entatio tten exa ake the ssmen date at ge of a	mination (approx. 90 to 1 hation of one candidate e lation in groups (groups c ort (approx. 8 to 10 pages n/talk (approx. 30 minute amination was chosen as e form of an oral examina- t is changed, the lecturer the latest. ssessment: English	20 minutes) or ach (approx. 30 minut of 2, approx. 30 minut o) or es). method of assessme tion of one candidate must inform student	ites) or tes per candidate) of ent, this may be char e each or an oral exar s about this by four y	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	ion of _l	olaces			
Additio	nal inf	ormation			
	-				
Worklo	ad				
210 h					
Teaching cycle					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)				
Module	e appea	ars in			
Master	's degr	ee (1 major) Quantum Eng	gineering (2020)		
Master	Master's degree (1 major) Quantum Engineering (2024)				

Module title			Abbreviation		
Current	t Topic	s in Physics			11-EXP8-Int-201-m01
Module coordinator Module offered by					
chairpe	erson o	f examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
8	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired.
Conten	ts				
Current univers	t topics sity or s	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of
Intende	ed lear	ning outcomes			
The stu physics a curren this kno	ident p s on Ma nt field owledg	osseses advanced knowl aster's level in the study p in physics and insight in ge. He/She is able to class	edge meeting the rec programme Nanostru to the measuring and sify and to link the le	quirements of a mod cture Technology. He d calculating method arnt. He/She knows	ule in theoretical or experimental e/She commands knowledge in Is which are necessary to acquire about fields of application.
Course	s (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)
V (4) + Module	R (2) e taugh	t in: English			
Methoo ster, in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
a) writte nutes) prox. 8 If a writ stead ta of asse nation Langua	en exal or c) or to 10 p tten exa ake the essmen date at age of a	mination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as e form of an oral examina t is changed, the lecturer t the latest. ssessment: English	20 minutes) or b) ora (groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate must inform student	Il examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	ion of p	olaces			
Additio	onal inf	ormation			
Worklo	ad				
240 h					
Teaching cycle					
Referre	ed to in	LPOI (examination regu	lations for teaching-o	degree programmes)	
			3	<u> </u>	
Module	e appea	ars in			
Master	's degr	ee (1 major) Quantum En	gineering (2020)		
Master	's degr	ee (1 major) Quantum En	gineering (2024)		

Module title			Abbreviation		
Nontechnical Special Topics 11-EXZ5-Int-201-m01				11-EXZ5-Int-201-m01	
Module	e coord	inator		Module offered by	
chairpe	erson o	f examination committee		Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
5	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired.
Conten	ts				
Additio study a	onal qua abroad.	alifications for engineers	. Credited academic a	achievements, e.g. ir	n case of change of university or
Intende	ed lear	ning outcomes			
The stu dy prog spectiv	ident p gram Na ve indus	ossesses advanced know anostructure Technology. strial research and develo	vledge meeting the re He/She commands l opment.	quirements of a moo knowledge qualifying	dule on Master's level in the stu- g him/her for a job in industry re-
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	in)
V (2) + Module	R (2) e taugh	t in: English			
Metho ster, in	d of ass formati	sessment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
nutes) prox. 8 If a wrift stead t of asse nation Langua	or c) or to 10 p tten exa ake the essmen date at age of a	al examination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as form of an oral examina t is changed, the lecturer the latest. ssessment: English	(groups of 2, approx /talk (approx. 30 min method of assessme tion of one candidate must inform student	a go minutes per can utes). ent, this may be chan each or an oral exa s about this by four	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	ion of p	olaces			
Additio	onal inf	ormation			
Worklo	ad				
150 h					
Teaching cycle					
Referre	ed to in	LPOI (examination regu	lations for teaching-c	legree programmes)	
Module	e appea	urs in			
Master	's degr	ee (1 major) Quantum En	gineering (2020)		
Master	's degr	ee (1 major) Quantum En	gineering (2024)		

Module title			Abbreviation			
Nontechnical Special Topics 11-EXZ6-Int-201-m01					11-EXZ6-Int-201-m01	
Module coordinator Module offered by						
chairpe	erson o	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Additio study a	nal qua broad.	alifications for engineers	. Credited academic a	achievements, e.g. ir	n case of change of university or	
Intende	ed learı	ning outcomes				
The stu dy prog spectiv	ident po gram Na re indus	ossesses advanced know anostructure Technology. strial research and develo	vledge meeting the re He/She commands I opment.	quirements of a moo knowledge qualifying	dule on Master's level in the stu- g him/her for a job in industry re-	
Course	s (type	, number of weekly conta	ict hours, language —	if other than Germa	n)	
V (3) + Module	R (1) e taugh	t in: English				
ster, ini a) writti nutes) prox. 8 If a writ stead ta of asse nation Langua Allocat	formati en exar or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p	on on whether module ca nination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as form of an oral examina t is changed, the lecturer the latest. ssessment: English blaces	an be chosen to earn 20 minutes) or b) ora (groups of 2, approx /talk (approx. 30 min method of assessme tion of one candidate must inform student	a bonus) l examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachi	Teaching cycle					
Referre	d to in	LPO I (examination regu	lations for teaching-c	legree programmes)		
				<u> </u>		
Module	Module appears in					
Master	's degr	ee (1 major) Quantum En	gineering (2020)			
Master	's degr	ee (1 major) Quantum En	gineering (2024)			

Module	title				Abbreviation
Field Theory in Solid State Physics			11-FFK-Int-201-m01		
Module	coord	inator		Module offered by	
Managi and Ast	ng Dire rophys	ector of the Institute of Th ics	eoretical Physics	Faculty of Physics a	nd 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 semes	ster	graduate			
Conten	ts				
This wil Green's An outli 1. Single 2. Revie 3. Diagr 4. Diagr 5. Land 6. Supe 7. One-o Intende Working ties of F	This will usually be a course on quantum many particle physics approached by the perturbative methods using Green's functions An outline could be: 1. Single-particle Green's function 2. Review of second quantization 3. Diagrammatic method using many particle Green's functions at temperature T=0 4. Diagrammatic method for finite T 5. Landau theory of Fermi liquids 6. Superconductivity 7. One-dimensional systems and bosonization Intended learning outcomes Working knowledge of the methods of quantum field theory in a non-relativistic context. Ability to study proper-				
sential Courses	for the s (type,	understanding the effect	s of interactions, inc ct hours, language –	luding superconduct	ivity and the Kondo effect. n)
V (4) + F Module	R (2) taugh	t in: English			
Method ster, inf	l of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English 					
Allocati	ion of p	olaces			
Additio	Additional information				
	-				
Worklo	ad				
240 h					
Teachin	ng cycle	2			
		-			
Deferre	d to !=	IDO L (oversingtion rest	lations for tasshing		
	Referred to in LPO I (examination regulations for teaching-degree programmes)				

Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title				Abbreviation		
Solid S	Solid State Physics 2 11-FK2-Int-201-m01					
Module coordinator Module offere			Module offered by			
Manag	ing Director of the Institute of	Applied Physics	Faculty of Physics a	nd Astronomy		
FCTS	Method of grading	Only after succ. con	nnl. of module(s)	,		
8	numerical grade					
Duratio	on Module level	Other prerequisites	• .• •	· · ·		
1 seme	ster graduate	Approval from exam	ination committee re	equirea.		
Conten	its					
 Electia. Electia. Electia. Electia. Electia. Electia. Sema. Electib. Fermic. Electid. Boltzia. The organization of the sema and the sem	Contents 1. Electrons in a periodic potential – the band structure a. Electrical and thermal transport b. Bloch theorem c. Electrons 2. Semi-classical models of dynamic processes a. Electrical transport in partially and completely filled bands b. Fermi surfaces; measurement techniques c. Electrical transport in external magnetic fields d. Boltzmann-equations of transport 3. The dielectric function and ferroelectrics a. Macroscopic electrodynamics and microscopic theory b. Polarizability of solids, of lattices, of valence electrons and quasi-free electrons; optical phonons, polaritons, plasmons, inter-band transitions, Wannier-Mott excitons c. Ferromagnetism 4. Semiconductors a. Object semiconductors c. Doped semiconductors d. Physics and applications of p-n junctions e. Heterostructures 5. Magnetism a. Atomic dia- and paramagnetism b. Dia- and paramagnetism c. Daped semiconductors c. Atomic dia- and paramagnetism b. Dia- and paramagnetism b. Dia- and paramagnetism c. Superconductivity					
Intend	ed learning outcomes					
Knowle ciples a	edge of effects, concepts and i and with applications of expe	nodels in advanced so imental methods.	lid state physics. Far	niliarity with the theoretical prin-		
Course	s (type, number of weekly con	tact hours, language –	- if other than Germa	n)		
V (4) + Module	R (2) e taught in: English					
Metho ster, in	d of assessment (type, scope, formation on whether module	language — if other th can be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
a) writt nutes) prox. 8	a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes).					
stead t of asse nation	ake the form of an oral examination was chosen ake the form of an oral examin essment is changed, the lectur date at the latest.	ation of one candidate ation of one candidate er must inform student	ent, this may be char e each or an oral exa s about this by four	mination in groups. If the method weeks prior to the original exami-		

Master's with 1 major Quantum Engineering (2024)

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Julius-Maximilians-UNIVERSITÄT WÜRZBURG

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

Allocation of places

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Additional information

Workload

240 h

Teaching cycle

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

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Module appears in

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

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

exchange program Physics (2023)

Master's degree (1 major) Quantum Engineering (2024)

Master's degree (1 major) Physics International (2024)

Module title			Abbreviation			
Solid S	Solid State Spectrocopy 11-FKS-Int-201-m01					
Modul	e coord	inator		Module offered by		
Manag	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	pl. of module(s)		
6	nume	rical grade				
Durati	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	nts					
Single spectre	and ma oscopy,	any particle picture of elec X-ray spectroscopies.	ctrons in solids, Light	-matter interaction,	Optical spectroscopy, Electron	
Intend	ed lear	ning outcomes				
Specifi py and scienc	ic and i I their a e.	n-depth knowledge of sol pplications. Understandi	id-sate spectroscopy ng of the theoretical p	. Knowledge of diffe principles and mode	rent methods of spectrosco- rn developments in the related	
Course	es (type	, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (3) + Modul	R (1) e taugh	t in: English				
Metho ster, in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
nutes) prox. 8 If a wri stead to of asse nation Assess Langua	or c) or 3 to 10 p tten exa take the essmen date at sment o age of a	al examination in groups bages) or e) presentation/ amination was chosen as e form of an oral examinat t is changed, the lecturer the latest. ffered: In the semester in ssessment: English	(groups of 2, approx. (talk (approx. 30 min method of assessme tion of one candidate must inform student which the course is	30 minutes per can utes). ent, this may be char each or an oral exa s about this by four offered and in the su	didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ibsequent semester	
Alloca		Diaces				
	nal inf	ormation				
Worklo	bad					
180 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	r's degr	ee (1 major) Physics Inter	national (2020)			
Master	r's degr	ee (1 major) Quantum Eng	gineering (2020)			
exchar	nge prog	gram Physics (2023)	/ 、			
Master	r's degr	ee (1 major) Quantum Eng	gineering (2024)			
master	Master's degree (1 major) Physics International (2024)					

Module title					Abbreviation
Visiting Research					11-FPA-Int-201-m01
Module	coord	inator		Module offered by	
chairpe	rson o	examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
10	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
		graduate	Approval from exam	ination committee re	equired.
Conten	ts				
Indeper analysi search	ndent v s and c institut	vork in a current research locumentation of the resu res.	topic in experimentaults, especially in the	al or theoretical phys context of research	sics. Experimental work including visits to other universities or re-
Intende	ed learr	ning outcomes			
Familia ability t	rity wit to analy	h current research topics /ze and document scient	in experimental or th ific experiments.	neoretical physics. W	/ithin experimental physics, the
Course	s (type,	, number of weekly conta	ct hours, language —	· if other than Germa	n)
R (o) Module	e taugh	t in: English			
Methoo ster, inf	l of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
project Langua	report ge of a	(10 to 20 pages) ssessment: English			
Allocat	ion of p	olaces			
Additio	nal info	ormation			
Worklo	ad				
300 h					
Teachir	ng cycl	9			
Referre	d to in	LPOI (examination regu	lations for teaching-c	legree programmes)	
Module	appea	rs in			
Master'	s degre	ee (1 major) Physics Inter	national (2020)		
Master'	s degre	ee (1 major) Quantum Eng	gineering (2020)		
Master'	s degre	ee (1 major) Quantum Eng	gineering (2024)		
Master'	s degre	ee (1 major) Physics Inter	national (2024)		

Module title				Abbreviation		
Profes	sional S	Specialization Quantum I	Engineering		11-FS-N-Int-201-m01	
Module	e coord	inator		Module offered by		
				Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
15	(not) s	successfully completed				
Duratio	on	Module level	Other prerequisites			
1 seme	ster					
Conten	ts					
Intend	ed lear	ning outcomes				
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)	
S (4)		· · · · · ·				
Module	e taugh	t in: English				
Metho	d of ass formati	sessment (type, scope, la	nguage — if other tha	an German, examina	tion offered — if not every seme-	
talk wit	th discu	ussion (20 to 45 minutos)				
Langua	age of a	ssessment: English				
Allocat	ion of _l	olaces				
Additio	onal inf	ormation				
Worklo	ad					
450 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	Master's degree (1 major) Quantum Engineering (2020)					
Master's degree (1 major) Quantum Engineering (2024)						

Module title					Abbreviation		
Optical	Optical Properties of Semiconductor Nanostructures 11-HNS-Int-201-m01						
Module	coord	nator		Module offered by			
Managi	ng Dire	ector of the Institute of <i>i</i>	Applied Physics	Faculty of Physics a	and Astronomy		
ECTS	Metho	d of grading	Only after succ. con	npl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
Conten	ts	graduate					
Semico or macr ging the tures of with a f of nove for qua	Semiconductor Nanostructures are frequently referred to as 'artificial materials'. In contrast to atoms, molecules or macroscopic crystals, their electronic, optical and magnetic properties can be systematically tailored via chan- ging their size. The lecture addresses technological challenges in the preparation of semiconductor nanostruc- tures of varying dimensions (2D, 1D, oD). It provides the basic theoretical concepts to describe their properties, with a focus on optical properties and light-matter coupling. Moreover, it discusses the challenges and concepts of novel optoelectronic and quantum photonic devices based on such nanostructures, including building blocks						
Intende	ed learr	ning outcomes					
Familia founda novel p	rity wit tions. k hotoni	h the fundamental prop (nowledge of the techn c devices.	perties of semiconduct ological methods to fa	or nanostructures as bricate such structu	s well as with their th res, and of their appl	eoretical lications to	
Course	s (type,	number of weekly con	tact hours, language –	- if other than Germa	ın)		
V (3) + I Module	R (1) e taugh	tin: English					
Methoo ster, inf	l of ass formati	essment (type, scope, on on whether module	language — if other the can be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-	
a) writte nutes) o prox. 8 If a writ stead ta of asse nation o Assesse Langua	en exar or c) or to 10 p ten exa ake the ssment date at ment o ge of a	nination (approx. 90 to al examination in group ages) or e) presentatio mination was chosen a form of an oral examin is changed, the lecture the latest. ffered: In the semester ssessment: English	120 minutes) or b) ora os (groups of 2, approx n/talk (approx. 30 min as method of assessm ation of one candidate er must inform student in which the course is	al examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa is about this by four offered and in the su	e candidate each (ap ididate) or d) project nged and assessmen mination in groups. weeks prior to the on ubsequent semester	oprox. 30 mi- report (ap- nt may in- If the method riginal exami-	
Allocati	ion of r	laces					
Additio	nal info	ormation					
Worklo	ad						
180 h							
Teachir	ng cycl	9					
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module	appea	rs in					
Master'	s degre	ee (1 major) Physics Int	ernational (2020)				
exchan	s uegre ge pros	ram Physics (2023)	ngmeening (2020)				
Master's wi	th 1 major	Quantum Engineering (2024)	JMU Würzburg ● ta record Master	generated 02-Apr-2024 • ex	am. reg. da- ering - 2024	page 54 / 86	



Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title	Abbreviation					
Semiconductor Physics 11-HPH-Int-201-m01						
Module coordinator Module	Module offered by					
Managing Director of the Institute of Applied Physics Faculty	of Physics and Astronomy					
ECTS Method of grading Only after succ. compl. of me	odule(s)					
6 numerical grade						
Duration Module level Other prerequisites						
1 semester graduate						
Contents						
The lecture deals with the fundamental properties of semiconductor structure, leading to methods for describing band structures. These tronic properties of monolithic semiconductors. It then turns to exan studies how these can be used to modify and design optical and ele lowered dimensionality systems. Examples are selected from curren	s. It begins with an analysis of the crystal form a basis for discussing optical and elec- nining semiconductor heterostructures, and ctrical properties, especially in the case of t research activities.					
Intended learning outcomes						
To provide the student with a working knowledge semiconductors pe and band structures, as well as electrical and optical properties. This the more targeted specially lectures in the program.	ertaining to crystal structure, symmetries, s establishes a solid basis preparing him for					
Courses (type, number of weekly contact hours, language — if other	than German)					
V (3) + R (1) Module taught in: English						
Method of assessment (type, scope, language — if other than Germa ster, information on whether module can be chosen to earn a bonus	an, examination offered — if not every seme-)					
nutes) 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester						
Allocation of places						
Additional information						
Warkland						
180 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree pr	rogrammes)					
Module appears in						
Master's degree (1 major) Physics International (2020)						
Master's degree (1 major) Quantum Engineering (2020)						
exchange program Physics (2023)						
Master's degree (1 major) Quantum Engineering (2024)						
imaster S with 1 major Quantum Engineering (2024) JMU wurzburg • generated o ta record Master (120 ECTS) (Iz-Api-2024 • exam. reg. ua- page 56 / 86 Quantum Engineering - 2024					

Module title			Abbreviation			
Magnetism 11-MAG-Int-201-mo					11-MAG-Int-201-m01	
Module	e coord	inator		Module offered by		
Manag	ing Dire	ector of the Institute of Ap	plied 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	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Dia- an ture, Na fect.	d parar anomaន្	nagnetism, Exchange int gnetism, Superparamagn	eraction, Ferromagne etism, Experimental	etism, Antiferromagn methods to measure	etism, Anisotropy, Domain struc- e magnetic properties. Kondo ef-	
Intende	ed learr	ning outcomes				
Knowle measu to appl se field	edge of re them y these ls. Capa	the basic terminology, co . Skills in constructing si skills to the mentioned f ability of assessing the pi	oncepts and phenom mple models and de fields of magnetism. recision of observatio	ena of magnetism ar scribing the mathem Competence to inde ons and of their anal	nd the experimental methods to natical formalism, and the ability pendently solve problems in the- ysis.	
Course	s (type,	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + Module	R (1) e taugh	t in: English				
Methor ster, in	d of ass formati	essment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua	en exar or c) or to 10 p tten exa ake the ssment date at ment o age of a	al examination (approx. 96 to 1 al examination in groups bages) or e) presentation/ amination was chosen as form of an oral examinat t is changed, the lecturer the latest. ffered: In the semester in ssessment: English	(groups of 2, approx (talk (approx. 30 min method of assessme tion of one candidate must inform student which the course is	a examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four offered and in the su	a candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester	
Allocat	ion of p	olaces				
Additio	nal info	ormation				
Worklo	ad					
180 h						
Teachi	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	's degre	ee (1 major) Physics Inter	national (2020)			
Master	's degre	ee (1 major) Quantum Eng	gineering (2020)			
exchan	ige prog	gram Physics (2023)				
Master	's degre	ee (1 major) Quantum Eng	gineering (2024)			
Master's degree (1 major) Physics International (2024)						

Module title Abbreviation				Abbreviation		
Master	Thesis	Quantum Engineering			11-MA-N-Int-201-m01	
Module	e coord	inator		Module offered by		
				Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
30	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Intend	ed lear	ning outcomes				
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)	
no cou Module	rses as e taugh	signed t in: English				
Metho	d of ass	sessment (type, scope, la	nguage — if other tha	an German, examina	tion offered — if not every seme-	
ster, in	formati	on on whether module ca	an be chosen to earn	a bonus)		
Master Langua	's thesi ige of a	s (750 to 900 hours total ssessment: English)			
Allocat	ion of p	olaces				
	-					
Additio	onal inf	ormation				
Time to	compl	ete: 6 months				
Worklo	ad					
900 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
	·					
Module	Module appears in					
Master	's degr	ee (1 major) Quantum Eng	gineering (2020)			
Master	Master's degree (1 major) Quantum Engineering (2024)					

Module title					Abbreviation	
Scientific Methods and Project Management Quantum Eng				neering	11-MP-N-Int-201-m01	
Module	e coord	inator		Module offered by		
				Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)		
15	(not) s	successfully completed				
Duratio	on	Module level	Other prerequisites			
1 seme	ster					
Conten	ts					
Intende	ed lear	ning outcomes				
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
R (4)						
Module	e taugh	t in: English				
Method ster, in	d of ass formati	sessment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
talk wit Langua	h discu ge of a	ussion (30 to 45 minutes) ssessment: English				
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
450 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					
Master	's degr	ee (1 major) Quantum En	gineering (2020)			
Master	Master's degree (1 major) Quantum Engineering (2024)					

Module title					Abbreviation		
Advanced Magnetic Resonance Imaging 11-MRI-Int-201-m01							
Modu	le coord	inator		Module offered by			
Manag	ging Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	and Astronomy		
ECTS	Metho	od of grading	Only after succ. cor	npl. of module(s)			
6	nume	rical grade					
Durati	on	Module level	Other prerequisites	i			
1 sem	ester	graduate					
Conte	nts						
Nuclea imagin the fun course 1) the 2) the and m 3) the 4) the	 Nuclear magnetic resonance (NMR) is a quantum mechanical phenomenon that, through magnetic resonance imaging (MRI), has played a major role in the revolution in medical imaging over the last 30 years. Starting from the fundamentals of nuclear magnetic resonance (resonance principle, relaxation times, chemical shift) this course covers 1) the NMR signal theory and signal evolution (Bloch equations) 2) the principles of spatial encoding, magnetic resonance imaging (MRI) and corresponding imaging sequences and measurement parameters, 3) the concept of k-space and Fourier imaging, 4) the physical, methodological and technical possibilities and limitations of MRI. Finally, typical application 						
Intend	led lear	ning outcomes			ig will be covered.		
The st tical-tl on/im plinar	udents a neoretic age-pro y relatio	are familiar with the bas al description and the p cessing principles. The ns and applications.	sics and the deepened bhysical basics of moc students gain a deep	l aspects of NMR and ern MRI, MRI-instrun insight into the area	l MRI including the n nentation and image of modern MRI and i	nathema- e-formati- its interdisci-	
Cours	es (type	, number of weekly con	tact hours, language -	- if other than Germa	an)		
V (3) + Modu	R (1) R taugh	t in: English					
Metho ster, in	od of ass nformati	essment (type, scope, on on whether module	language — if other th can be chosen to earr	an German, examina a bonus)	ition offered — if not	every seme-	
a) writ nutes) prox. 8 If a wr stead of ass nation Asses Langu	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. Assessment offered: In the semester in which the course is offered and in the subsequent semester						
Alloca	tion of p	olaces					
Additi	onal inf	ormation					
Workl	Workload						
180 h							
Teach	ing cvcl	e					
Teach	Teaching cycle. In the semester in which the course is offered and in the subsequent semester						
Referr	Referred to in LPO L (examination regulations for teaching-degree programmes)						
			,	<u> </u>			
L							
Master's v	with 1 majo	r Quantum Engineering (2024)	JMU Würzburg • ta record Maste	9 generated 02-Apr-2024 • ex r (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 60 / 86	

Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title		Abbreviation					
Nano-Optics 11-NOP-Int-201-m01					L		
Module coord	inator		Module offered by				
Managing 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						
Duration	Module level	Other prerequisites					
1 semester	graduate						
Contents							
The lecture co from the discu copy are discu basis, quantu 2D, 1D and o tennas.	nveys theoretical funda ussion of the focusing o ussed. In the following, m emitters are introduc dimensions are introduc	mentals, experimenta f light. Based on this, the near-field optical r ed and their light emis red and discussed in c	l techniques, and ap the fundamentals of nicroscopy is introdu ssion in nano-enviror letail. This finally lea	plications of nano-o modern far-field opt uced and discussed. uments is derived. Pl ds to the concept of	ptics starting ical micros- As a further asmons in optical an-		
Intended lear	ning outcomes						
Specific and i and application	n-depth knowledge of t ons of nano-optics as w	ne topic of nano-optics ell as the current deve	s. Familiarity with the lopments of the topic	e basic theoretical de c.	escription		
Courses (type	, number of weekly con	tact hours, language –	- if other than Germa	n)			
V (3) + R (1) Module taugh	t in: English						
Method of ass ster, informat	sessment (type, scope, ion on whether module	language — if other th can be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-		
nutes) or c) or prox. 8 to 10 p If a written existent stead take the of assessmen nation date at Assessment o Language of a	al examination in group pages) or e) presentatio amination was chosen a e form of an oral examin t is changed, the lecture the latest. ffered: In the semester ssessment: English	is (groups of 2, approx n/talk (approx. 30 min as method of assessm ation of one candidate er must inform student in which the course is	a. 30 minutes per can utes). ent, this may be chan e each or an oral exa ts about this by four offered and in the su	didate) or d) project nged and assessmer mination in groups. I weeks prior to the or Ibsequent semester	report (ap- nt may in- lf the method 'iginal exami-		
Allocation of	olaces						
Additional inf	ormation						
Workload		_					
190 h							
Teaching cycl	e						
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appea	Module appears in						
Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024)							
Master's with 1 main	r Ouantum Engineering (2024)		generated 02-Apr-2024 • example	am. reg. da-	page 62 / 86		
		ta record Maste	r (120 ECTS) Quantum Engine	ering - 2024			

Module title				Abbreviation	
Organ	Organic Semiconductors 11-OHL-Int-201-m01				
Modul	e coord	linator		Module offered by	
Prepar	ation a	nd safety briefing		Faculty of Physics a	nd Astronomy
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)	
6	nume	rical grade			
Durati	on	Module level	Other prerequisites		
1 seme	ester	graduate			
Conte	nts				
Funda ons.	mentals	s of organic semiconducto	ors, molecular and po	olymer electronics ar	nd sensor technology, applicati-
Intend	ed lear	ning outcomes			
In-dep	th knov	vledge of the properties o	f organic semicondu	ctor materials and th	eir applications.
Course	es (type	. number of weekly conta	ct hours, language –	- if other than Germa	 n)
V (3) + Modul	R (1) e taugh	it in: English	, , , ,		<u></u>
Metho ster, ir	d of as	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
d) proj e) pres If a wri stead of asso nation Assess Langu	ect rep sentatio itten ex- take the essmen date at sment o age of a	ort (approx. 8 to 10 pages on/talk (approx. 30 minute amination was chosen as e form of an oral examina- it is changed, the lecturer t the latest. offered: In the semester in assessment: English) or es). method of assessme tion of one candidate must inform student which the course is	ent, this may be chan e each or an oral exa is about this by four offered and in the su	nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester
Alloca	tion of	places			
Additi	onal inf	ormation			
Workl	oad				
180 h					
Teach	ing cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in					
Maste	Master's degree (1 major) Physics International (2020)				
Maste	r's degr	ee (1 major) Quantum Eng	gineering (2020)		
excha	nge pro	gram Physics (2023)			
Maste	r's degr	ee (1 major) Quantum Eng	gineering (2024)		
Maste	Master's degree (1 major) Physics International (2024)				

Module title				Abbreviation	
Advanc	Advanced Seminar Quantum Engineering A 11-OSN-A-Int-201-m01				
Module	Module coordinator Module offered by				
Manag	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
5	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
Semina	ar on cu	irrent issues in theoretica	al or experimental phy	/sics.	
Intende	ed lear	ning outcomes			
In-dept tions, s	h know summa	vledge about a current top rizing them and presentir	pic in experimental on them to a peer aud	r theoretical physics lience.	. Ability to read scientific publica-
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)
S (2) Module	e taugh	t in: English			
Method ster, in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-
talk wit Langua	h discu ge of a	ussion (30 to 45 minutes) ssessment: English			
Allocat	ion of _l	olaces			
Additio	nal inf	ormation			
Worklo	ad				
150 h					
Teachi	ng cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in					
Master	's degr	ee (1 major) Quantum Eng	gineering (2020)		
exchan	ge pro	gram Physics (2023)			
Master	Master's degree (1 major) Quantum Engineering (2024)				

Module title					Abbreviation		
Advanc	Advanced Seminar Quantum Engineering B 11-OSN-B-Int-201-m01						
Module	e coord	inator		Module offered by			
Manag	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	pl. of module(s)			
5	nume	rical grade					
Duratio	on	Module level	Other prerequisites	r prerequisites			
1 seme	ster	graduate					
Conten	ts						
Semina	ar on cu	irrent issues in theoretica	al or experimental phy	/sics.			
Intende	ed lear	ning outcomes					
In-dept tions, s	h know umma	vledge about a current to rizing them and presentir	pic in experimental or ng them to a peer aud	r theoretical physics lience.	. Ability to read scientific publica-		
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
S (2) Module	e taugh	t in: English					
Method ster, in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
talk wit Langua	h discu ge of a	ussion (30 to 45 minutes) ssessment: English					
Allocat	ion of J	olaces					
Additio	nal inf	ormation					
Worklo	ad						
150 h							
Teachi	Teaching cycle						
Referre	d to in	LPOI (examination regu	lations for teaching-c	legree programmes)			
Module appears in							
Master	's degr	ee (1 major) Quantum Eng	gineering (2020)				
exchan	exchange program Physics (2023)						
Master's degree (1 major) Quantum Engineering (2024)							

Module title					Abbreviation		
Advanced Laboratory Course Master Part 1 11-P-FM1-Int-201-m01							
Module coordinator				Module offered by			
Managing Director of the Institute of Ap		plied Physics	d Physics Faculty of Physics and Astronomy				
ECTS Method of grading Only after succ. c			Only after succ. com	pl. of module(s)			
3	(not)	successfully completed	-				
Durati	on	Module level	Other prerequisites				
1 seme	ester	graduate	Preparation and safe	ety briefing.			
Conte	nts						
Found solid s tic res condu	ations o state pro onance ctivity,	of particle, atomic and mo operties, surfaces and int (NMR), quantum Hall effe lasers, solid state optics	olecular physics, low- erfaces. Experiments ect, optical pumping a	temperature experin covering the topics and spectroscopy wi	nents and correlated systems, x-ray radiation, nuclear magne- th visible light, Hall effect, super-		
Intend	ed lear	ning outcomes					
Solid s ledge ge of e preser	skills in of how t experim nting an	performing an experimer to prepare a scientific pul ental methods, of using s d discussing the results i	it and analyzing and olication and use stat cientific publications n the form of a scient	documenting the exp te-of-the-art analysis s, of performing and tific publication.	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and		
Course	es (type	, number of weekly conta	ct hours, language —	· if other than Germa	n)		
P (3) Modul	e taugh	t in: English					
Metho ster, ir	d of as format	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
practic Studen fic pub succes regula Langu	practical examination Students must successfully prepare, perform, document (lab notebook) and evaluate (in the form of a scienti- fic publication) an experiment to be considered to have successfully completed this experiment. Students must successfully complete two experiments to be considered to have successfully completed this module. Detailed regulations are laid down in the respective module description.						
Alloca	tion of	places					
Additi	onal inf	ormation					
Workl	oad						
90 h	90 h						
Teach	Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Modu	Module appears in						
Maste	Master's degree (1 major) Physics International (2020)						
Maste	Master's degree (1 major) Quantum Engineering (2020)						
excha	exchange program Physics (2023)						
Maste	Master's degree (1 major) Quantum Engineering (2024)						
Maste	Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation		
Advanced Laboratory Course Master Part 2 11-P-FM2-Int-201-m01							
Module coordinator				Module offered by			
Managing Director of the Institute of Ap		oplied Physics	blied Physics Faculty of Physics and Astronomy				
ECTS Method of grading Only after succ.			Only after succ. com	ompl. of module(s)			
3	(not)	successfully completed					
Durati	on	Module level	Other prerequisites	rerequisites			
1 seme	ester	graduate	Preparation and safe	aration and safety briefing.			
Conte	nts						
Found solid s tic res condu	ations o state pro onance ctivity,	of particle, atomic and mo operties, surfaces and int (NMR), quantum Hall effe lasers, solid state optics	blecular physics, low- erfaces. Experiments ect, optical pumping a	temperature experin covering the topics and spectroscopy wi	nents and correlated systems, x-ray radiation, nuclear magne- th visible light, Hall effect, super-		
Intend	ed lear	ning outcomes					
Solid s ledge ge of e preser	skills in of how t experim nting an	performing an experimer to prepare a scientific pul ental methods, of using s d discussing the results i	nt and analyzing and plication and use stat cientific publications n the form of a scient	documenting the exp te-of-the-art analysis 5, of performing and tific publication	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and		
Course	es (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)		
P (3) Modul	e taugh	t in: English					
Metho ster, in	d of as	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
praction Studen fic pub succes regula Langu	practical examination Students must successfully prepare, perform, document (lab notebook) and evaluate (in the form of a scienti- fic publication) an experiment to be considered to have successfully completed this experiment. Students must successfully complete two experiments to be considered to have successfully completed this module. Detailed regulations are laid down in the respective module description.						
Alloca	tion of	places					
Additi	onal inf	ormation					
Workl	oad						
90 h							
Teach	Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Modu	Module appears in						
Maste	r's degr	ee (1 major) Physics Inter	national (2020)				
Maste	Master's degree (1 major) Quantum Engineering (2020)						
exchar	exchange program Physics (2023)						
Maste	r's degr	ee (1 major) Quantum Eng	gineering (2024)				
inaste	Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation		
Advanced Laboratory Course Master Part 3 11-P-FM3-Int-201-m01							
Module coordinator				Module offered by			
Managing Director of the Institute of Ap		plied Physics	Faculty of Physics a	nd Astronomy			
ECTS Method of grading Only after succ. compl. of modul			pl. of module(s)				
3	(not)	successfully completed					
Durati	on	Module level	Other prerequisites				
1 seme	ester	graduate	Preparation and safe	ety briefing.			
Conte	nts						
Found solid s tic res condu	ations o state pro onance ctivity,	of particle, atomic and mo operties, surfaces and int (NMR), quantum Hall effe lasers, solid state optics	olecular physics, low- erfaces. Experiments ect, optical pumping a	temperature experin covering the topics and spectroscopy wi	nents and correlated systems, x-ray radiation, nuclear magne- th visible light, Hall effect, super-		
Intend	ed lear	ning outcomes					
Solid s ledge ge of e preser	skills in of how t experim nting an	performing an experimer to prepare a scientific pul ental methods, of using s d discussing the results i	it and analyzing and olication and use stat cientific publications n the form of a scient	documenting the exp te-of-the-art analysis s, of performing and tific publication.	perimental outcome. Basic know- systems and software. Knowled- evaluating an experiment, and		
Course	es (type	, number of weekly conta	ct hours, language —	· if other than Germa	n)		
P (3) Modul	e taugh	t in: English					
Metho ster, ir	d of as format	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
practic Studen fic pub succes regula Langu	practical examination Students must successfully prepare, perform, document (lab notebook) and evaluate (in the form of a scienti- fic publication) an experiment to be considered to have successfully completed this experiment. Students must successfully complete two experiments to be considered to have successfully completed this module. Detailed regulations are laid down in the respective module description.						
Alloca	tion of	places					
Additi	onal inf	ormation					
Workl	oad						
90 h							
Teach	Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Modu	Module appears in						
Maste	r's degr	ee (1 major) Physics Inter	national (2020)				
Maste	Master's degree (1 major) Quantum Engineering (2020)						
excha	exchange program Physics (2023)						
Maste	Master's degree (1 major) Quantum Engineering (2024)						
Maste	Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation		
Advanced Laboratory Course Master Part 4							
Module coordinator				Module offered by			
Managing Director of the Institute of Ap		oplied Physics	plied Physics Faculty of Physics and Astronomy				
ECTS Method of grading Only after succ.			Only after succ. com	ompl. of module(s)			
3	(not)	successfully completed					
Durati	on	Module level	Other prerequisites	prerequisites			
1 seme	ester	graduate	Preparation and safe	paration and safety briefing.			
Conte	nts						
Found solid s tic res condu	ations o state pro onance ctivity,	of particle, atomic and mo operties, surfaces and int (NMR), quantum Hall effe lasers, solid state optics	olecular physics, low- erfaces. Experiments ect, optical pumping a	temperature experin covering the topics and spectroscopy wi	nents and correlated systems, x-ray radiation, nuclear magne- th visible light, Hall effect, super-		
Intend	ed lear	ning outcomes					
Solid s ledge ge of e preser	skills in of how t experim nting an	performing an experimer to prepare a scientific pul ental methods, of using s d discussing the results i	nt and analyzing and olication and use stat cientific publications n the form of a scient	documenting the exp te-of-the-art analysis 5, of performing and tific publication.	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and		
Course	es (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)		
P (3) Modul	e taugh	t in: English					
Metho ster, in	d of as	sessment (type, scope, la ion on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
practic Studen fic pub succes regula Langu	practical examination Students must successfully prepare, perform, document (lab notebook) and evaluate (in the form of a scienti- fic publication) an experiment to be considered to have successfully completed this experiment. Students must successfully complete two experiments to be considered to have successfully completed this module. Detailed regulations are laid down in the respective module description.						
Alloca	tion of	places					
Additi	onal inf	ormation					
Workl	oad						
90 h							
Teach	Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Modu	Module appears in						
Maste	r's degr	ee (1 major) Physics Inter	national (2020)				
Maste	Master's degree (1 major) Quantum Engineering (2020)						
exchar	exchange program Physics (2023)						
Maste	r's degr	ee (1 major) Quantum Eng	gineering (2024)				
inaste	Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation		
Physics of Advanced Materials 11-PMM-Int-201-m01							
Module coordinator				Module offered by			
Managing Director of the Institute of Ap			plied Physics Faculty of Physics and Astronomy				
ECTS Method of grading Only after succ.			Only after succ. con	ompl. of module(s)			
6	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
Genera als and groups	l prope super . Two-d	erties of various material g conductors; thin films, he limensional layered struc	groups such as liquic eterostructures and s tures.	ls, liquid crystals and uperlattices. Methoc	d polymers; magnetic materi- ls to characterize these material		
Intend	ed lear	ning outcomes					
Familia	rity wit	h the properties and cha	racterization method	s of various groups o	of modern materials.		
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)		
V (3) + Module	R (1) e taugh	t in: English					
Metho ster, in	d of ass formati	sessment (type, scope, la ion on whether module ca	nguage — if other than be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-		
prox. 8 If a wri stead t of asse nation Assess Langua	to 10 p tten exa ake the essmen date at ment o age of a	arexamination in groups bages) or e) presentation/ amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ffered: In the semester in ssessment: English	/talk (approx. 30 min method of assessme tion of one candidate must inform student	offered and in the su	nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester		
Allocat	ion of p	olaces					
Additio	onal inf	ormation					
Worklo	ad						
180 h							
Teachi	ng cycl	e					
Referred to in LPO I (examination regulations for teaching-degree programmes)							
				<u> </u>			
Module appears in							
Master Master exchar Master Master	Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation			
Phenon	Phenomenology and Theory of Superconductivity 11-PTS-Int-201-m01							
Module coordinator				Module offered by				
Managing Director of the Institute of Applied Physics and Managing Director of the Institute of Theoretical Physics and Astrophysics								
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)				
6	nume	rical grade						
Duratio	n	Module level	Other prerequisites	Other prerequisites				
1 seme	ster	graduate						
Conten	ts							
Basic P materia vention superco grams a des, ph of the F on of cu Intende Acquisi derstam arch. Ku as well tors and	Basic Properties of Superconductors and their Applications, Development of technological platforms, Methods of material science for calculating temperature profiles in superconductors. Overview of the phenomenology of con- ventional and unconventional superconductivity. Review of BCS theory and its applicability for different types of superconductors. Extension of Ginzburg-Landau theory to a quantum field theory formalism using Feynman dia- grams and functional integrals. Theoretical formalism of Ward identities and response functions. Goldstone mo- des, phase fluctuations, and coupling to the electromagnetic field. Interpretation of the Meissner effect in terms of the Higgs mechanism. Interplay of magnetism and conventional/unconventional superconductivity. Discussi- on of current research topics and perspective on room-temperature superconductivity. Intended learning outcomes Acquisition of basic knowledge about superconductivity as a macroscopic quantum phenomenon. Profound un- derstanding of unconventional superconductivity and its interplay with magnetism in the context of current rese- arch. Knowledge of BCS mean-field theory, the quantum-field theory methods necessary to extend BCS theory, as well as the Meissner effect and the Higgs mechanism. Basic understanding of unconventional superconduc- tors and their fascinating connection with compating magnetic phases							
Course	s (type	, number of weekly cont	act hours, language –	– if other than Germa	n)			
V (3) + I Module	R (1) e taugh	t in: English						
Method ster, inf	l of ass formati	essment (type, scope, on on whether module	anguage — if other th can be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-		
a) writte nutes) o prox. 8 If a writ stead ta of asse nation o Assesse Langua	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. Assessment offered: In the semester in which the course is offered and in the subsequent semester							
Allocat	ion of p	olaces						
Additio	Additional information							
Workload								
180 h								
Teachir	Teaching cycle							
Referred to in LPO I (examination regulations for teaching-degree programmes)								
Master's wi	- aster's with 1 major Quantum Engineering (2024) JMU Würzburg • generated 02-Apr-2024 • exam. reg. da- ta record Master (120 ECTS) Quantum Engineering - 2024							

Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)
Module	Module title		Abbreviation			
Advanced Theory of Quantum Computing and Quantum Information			11-QIC-Int-201-m01			
Module	e coord	inator		Module offered by		
Managing Director of the Institute of Theoretical Physics and Astrophysics			Theoretical Physics	Faculty of Physics a	ind 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	graduate				
Conten	ts					
1. Brief 2. Quar 3. Com 4. Entar 5. Quar 6. Quar 7. Flem	summa ntum th posite s ngleme ntum op ntum ga ents of	ary of classical informa leory seen from the per systems and the Schm ent measures perations, POVMs, and ates and quantum com the theory of decohere	tion theory spective of information dt decomposition the theorems of Kraus puters	n theory and Stinespring		
Intondo	d loar	ing outcomes				
Comprehensive understanding of quantum states and identity matrix beyond the usual textbook interpretation. Knowledge of handling tensor products and dealing with quantum effects in multipartite quantum systems. In- depth understanding of the phenomenon of entanglement. Knowledge of the fundamental mathematical con- cepts of quantum information theory. Ability to assess the limitations of quantum computing arising from deco- herence.						
Course	s (type,	, number of weekly con	tact hours, language –	- if other than Germa	ın)	
V (3) + I Module	R (1) e taugh	t in: English				
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)						
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester						
Allocat	ion of p	olaces				
	<u></u>					
Additional information						
Workload						
180 h						
Teaching cycle						
Referred to in IPO I (examination regulations for teaching degree programmes)						
Module	e appea	irs in				
Master's wi	th 1 major	Quantum Engineering (2024)	JMU Würzburg • ta record Master	generated 02-Apr-2024 • ex (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 73 / 86

Module	Module title		Abbreviation			
Quantum Mechanics II				11-QM2-Int-201-m01		
Module	e coord	inator		Module offered by		
Manag and As	ing Dire trophys	ector of the Institute of T sics	heoretical Physics	Faculty of Physics and Astronomy		
ECTS Method of grading Only after succ.				npl. of module(s)		
8	nume	rical grade				
Duration Module level Other prerequisites						
1 seme	1 semester undergraduate					
Contents						
 "Quantum mechanics 2" constitutes the central theoretical course to be taken within the international Master's program in physics. While the specific emphasis can be adjusted individually, the core topics that are supposed to be covered should include: Second quantization: fermions and bosons Band structures of particles in a crystal Angular momentum, symmetry operators, Lie Algebras Scattering theory: potential scattering, partial wave expansion Relativistic quantum mechanics: Klein-Gordon equation, Dirac equation, Lorentz group, fine structure splitting of atomic spectra Quantum entanglement Canonical formalism Intended learning outcomes In-depth knowledge of advanced quantum mechanics. Thorough understanding of the mathematical and theoretical concepts of the listed topics. Ability to describe or model problems of modern theoretical quantum physics mathematically, to solve problems analytically or using approximation methods and to interpret the results phy- 						
matter,	/solid s	tate physics. The cours	e is mandatory for all l	Master's students. - if other than Germa	n)	
V (4) +	R (2)	, number of weekly com				
Module	e taugh	t in: English				
Methor ster, in	d of ass formati	essment (type, scope, l on on whether module	anguage — if other th can be chosen to earn	an German, examina a bonus)	tion offered — if not ev	/ery seme-
 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English 						
Allocation of places						
Additional information						
Workload						
240 h						
Teaching cycle						
Master's w	ith 1 majo	r Quantum Engineering (2024)	JMU Würzburg • ta record Maste	generated 02-Apr-2024 • exa (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 75 / 86

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

Module appears in

Module	Module title			Abbreviation		
Quantum Transport 11-QTR-Int-201-m01						
Module coordinator Module offered by			Module offered by			
Managing Director of the Institute of Applied Physics Faculty of Physics and Astronomy						
ECTS Method of grading Only after succ. compl. of module(s)						
6	numer	ical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
The lec action as well the qua of supe Low din vant m tals, ar	ture ad and the as the antum F ercondu mension aterial s ad topol	dresses the fundamental wave nature are the det Coulomb blockade. Obse lall effect will be discuss ctivity will be examined hal electron systems and systems are semiconductors.	l transport phenomer ermining factors. This ervations of electron ed. Thermoelectric p as well. its quantum mechar tor heterostructures a The content will be g	na of electrons in sol s includes the diffusi interference effects, roperties of electron nical description are as well as topologica guided by actual rese	ids where Electron-e ive and ballistic tran conductance quanti ic system and the ph the basis of this lect l insulators, topolog earch results.	electron inter- sport regime zation and nenomenon cure. Rele- rical semime-
Intend	ed learr	ing outcomes				
Workin to disc	g know uss resi	ledge of basic transport o ults critical.	experiments, its anal	ysis and its interpret	ation which enables	the student
Course	s (type,	number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + Module	R (1) e taught	in: English				
Metho ster, in	d of ass formati	essment (type, scope, la on on whether module ca	nguage — if other than be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-
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. Assessment offered: In the semester in which the course is offered and in the subsequent semester						
Allocat	ion of p	laces				
Additio	onal info	ormation				
Worklo	Workload					
180 h						
וכמנווווא ניונים						
Doforra	d to in	IDOL (avamination regu	lations for toaching	dagraa programmac)		
Keterred to In LPU I (examination regulations for teaching-degree programmes)						
Module	e appea	rs in				
Master	s degre	e (1 major) Physics Inter	national (2020)			
exchan	s uegit	rram Physics (2022)	5mccning (2020)			
Master's w	ith 1 major	Quantum Engineering (2024)	IMII Würzburg●	generated 02-Anr-2024 • example	am, reg. da-	page 77 / 86
			ta record Master	(120 ECTS) Quantum Engine	ering - 2024	F-30///00



Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Modul	e title				Abbreviation	
Spintro	Spintronics 11-SPI-Int-201-m01					
Module coordinator Module offered by						
Manag	Managing Director of the Institute of Applied Physics Faculty of Physics and Astronomy			ind Astronomy		
ECTS	ECTS Method of grading Only after succ. compl. of module(s)					
6	nume	rical grade				
Duratio	Duration Module level Other prerequisites					
1 seme	ester	graduate				
Conter	nts					
In this giant n current	lecture, nagnetc t-induce	the basic principles of s presistance and tunnel ma ed spin phenomena are d	pin transport are tau agnetoresistance. Ne liscussed.	ght, with a particular w phenomena from	r emphasis on the phenomena of the fields of spin dynamics and	
Intend	ed learı	ning outcomes				
Knowle nology stance	edge of 7. Overvi).	basic principles of spin t ew over the state-of-the-	ransport models and art findings in this fie	of applications of sp eld (giant magnetore	pin transport in information tech- sistance, tunnel magnetoresi-	
Course	es (type	, number of weekly conta	ct hours, language —	- if other than Germa	in)	
V (3) + Modul	R (1) e taugh	t in: English				
Metho ster, in	d of ass Iformati	e ssment (type, scope, la on on whether module ca	nguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not every seme-	
nutes) 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester						
Allocat	tion of p	olaces				
Additio	onal inf	ormation				
Worklo	Workload					
180 h						
Teachi	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master	r's degr	ee (1 major) Physics Inter	national (2020)			
Master	r's degre	ee (1 major) Quantum Eng	gineering (2020)			
exchar	nge prog	gram Physics (2023)				
Master	r's degre	ee (1 major) Quantum Eng	gineering (2024)			
Master's degree (1 major) Physics international (2024)						

Module title			Abbreviation			
Surface Science 11-SSC-Int-201-m01						
Module coordinator Module offered by						
Managi	ing Dire	ng Director of the Institute of Applied Physics Faculty 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	graduate				
Conten	ts					
Relevar Atomic surface faces, c tism	nce of s structu , therm chemica	urfaces and interfaces ire: reconstructions and odynamics, adsorption al bonding, surface sta	distinction from bulk dadsorbates, surface of and desorption, Expe tes, spin-orbit coupling	phases, classical de prientation and symr rimental characteriz g, Rashba effects, top	scription, continuum netries, Microscopic ation, Electronic stru pological surface sta	n models, processes at cture of sur- tes, magne-
Intende	ed learr	ning outcomes				
The stu charact investi	dents ł teristic gation c	nave an overview over t of surfaces and interfa of surfaces, as well as t	he diverse aspects of s ces. The students knov heir specific fields of a	surface science and t v the most important pplication.	they are familiar with experimental techn	ı the physical iques for the
Course	s (type,	number of weekly con	tact hours, language –	- if other than Germa	n)	
V (3) + Module	R (1) e taugh	t in: English				
Methoo ster, in	l of ass formati	essment (type, scope, on on whether module	language — if other the can be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-
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. Assessment offered: In the semester in which the course is offered and in the subsequent semester						
Allocat	ion of p	olaces				
Additio	nal info	ormation				
Worklo						
180 h						
Teeshi		-				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	annea	rs in				
Master	's degre	e (1 major) Physics Int	ernational (2020)			
Master	's degre	ee (1 major) Quantum E	ngineering (2020)			
exchange program Physics (2023)						
Master's degree (1 major) Quantum Engineering (2024)						
Master	Master's degree (1 major) Physics International (2024)					
Master's wi	ith 1 major	Quantum Engineering (2024)	JMU Würzburg •	generated 02-Apr-2024 • exa	am. reg. da-	page 80 / 86
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Module title	Module title		Abbreviation		
Topological Effects in Solid State Physics			11-TEFK-Int-201-m01		
Module coordinator		Module offered by			
Managing Director of the Institute of T and Astrophysics	heoretical 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	i			
1 semester graduate					
Contents					
 Geometric phase in quantum systems Mathematical basics of topology Time-reversal symmetry Hall conductance and Chern numbers Bulk-boundary correspondence Graphene (as a topological insulator) Quantum Spin Hall insulators Z2 invariants 					
9. Topological superconductors	_				
Intended learning outcomes In-depth theoretical understanding of the topological concepts in quantum physics related to solid state sy- stems. Ability to connect their knowledge with different research activities at the Department of Physics and Astronomy at Würzburg University. Courses (type, number of weekly contact hours, language — if other than German) V (4) + R (2) Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English					
Allocation of places					
Additional information					
Workload					
240 h					
Teaching cycle					
Referred to in LPO I (examination reg	ulations for teaching-	degree programmes)			
Module appears in					

Module title		Abbreviation			
Theoretical Solid State Physics					11-TFK-Int-201-m01
Module	coord	inator		Module offered by	
Managi and Ast	ng Dire rophys	ector of the Institute of Th sics	eoretical 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	n	Module level	Other prerequisites		
1 semes	ster	graduate			
Conten	ts				
The contents of this two-term course will depend on the choice of the lecturer, and may include parts of the syllabus which could alternatively be offered as "Quantum Many Body Physics" (11-QVTP). A possible syllabus may be: 1. Band structure (Sommerfeld theory of metals, Bloch theorem, k.p approach and effective Hamiltonians for to- pological insulators (TIs), bulk-surface correspondence, general properties of TIs) 2. Electron–electron interactions in solids (path integral method for weakly interacting fermions, mean field theory, random phase approximation (RPA), density functional theory)					
4. BCS	theory	of superconductivity			
Intende	d lear	ning outcomes			
In-dept apply th standar	h know ne met rd textb	/ledge of the topics listed hods listed. This provides books on theoretical solic	l above. In-depth unc s a thorough working l state physics.	lerstanding of the co knowledge of a larg	ncepts involved and ability to e number of topics treated in the
Courses	s (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)
V (4) + I Module	R (2) taugh	t in: English			
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)					
a) written examination (approx. 90 to 120 minutes) 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester language of assessment: English					
Allocation of places					
Additional information					
Worklo	ad				
240 h					
Teachir	ıg cycl	e			
Referre	d to in	LPOI (examination regu	lations for teaching-o	legree programmes)	
Module	appea	urs in			
mould	~~~~				

Master's with 1 major Quantum Engineering (2024)

Modul	Module title Abbreviation					
Theoretical Quantum Optics				11-TQO-Int-221-m01		
Modul	e coord	inator		Module offered by		
Manag and As	ging Dire strophy:	ector of the Institute of Tl sics	neoretical Physics	Faculty of Physics and Astronomy		
ECTS Method of grading Only after succ.				pl. of module(s)		
8 numerical grade						
Duration Module level Other prerequisites						
1 seme	1 semester graduate					
Contents						
1. Sem 2. Inter 3. Mas 4. Cohr 5. Cohr 6. Phot	ii-classi raction ter equ erence erent lig ton stat	cal atom-field interaction of atoms with quantized ation and open systems and interference effects ght propagation in reson- istics and correlations ptics of many-body syste	ns light fields and dress ant media	ed-atom model		
Intend	ed lear	ning outcomes				
Compr cal lev ln-dep tistics Lindbla on effe diance	Comprehensive understanding of phenomena involving light and its interaction with atoms at the microscopi- cal level. Knowledge of density matrix formalism for quantum systems and the related mathematical concepts. In-depth understanding of quantum properties of light and their experimental signatures, including photon sta- tistics and correlations. Knowledge of the theory of open systems and master equation description involving Lindblad superoperators. Understanding and modeling the role of coherence and interference in light propagati- on effects in resonant atomic media. Knowledge of cooperative effects in many-body systems: super- and subra-					
Course	es (type	, number of weekly conta	act hours, language –	- if other than Germa	n)	
V (4) + Modul	R (2) e taugh	t in: English				
Metho ster, in	d of as format	sessment (type, scope, la ion on whether module c	anguage — if other tha an be chosen to earn	an German, examina a bonus)	tion offered — if not	every seme-
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 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester						
Allocation of places						
			_			
Additio	onal inf	ormation				
Workle	had		-			
240 h						
Teach	ing cycl	e	-			
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
		. <u> </u>			·	
Master's w	/ith 1 majo	r Quantum Engineering (2024)	JMU Würzburg • ta record Master	generated 02-Apr-2024 • exa (120 ECTS) Quantum Engine	am. reg. da- ering - 2024	page 85 / 86

Module appears in

Master's degree (1 major) Physics International (2020)
Master's degree (1 major) Quantum Engineering (2020)
Master's degree (1 major) Quantum Engineering (2024)
Master's degree (1 major) Physics International (2024)