

Sommersemester 26

Module Guide

for the study of

Master Physics

Masterstudiengang

valid in connection with the examination regulations MPO 2025

- Entwurf für erste Lesung -

Anlage 1: Studienverlaufsplan des Masterstudiengangs „Physics“

Der Studienverlaufsplan stellt eine Empfehlung dar, Module können von den Studierenden in einer anderen Reihenfolge besucht werden.

		Focus Areas, 84 CP				General Studies, 6 CP	Master Thesis, 30 CP	Σ 120 CP
		Fundamentals Focus Area A, Compulsory Modules, 18 CP	Fundamentals Focus Area B, Compulsory Modules, 18 CP	Fundamentals Focus Area C, Compulsory Modules, 18 CP	Specialization, Compulsory Modules, 30 CP	Elective Area	Compulsory Module	
1. Jahr	1. Sem.	gemäß Anlage 2.2.1: Research Lab A, 3 CP;	gemäß Anlage 2.2.1: Research Lab B, 3 CP;	gemäß Anlage 2.2.1: Research Lab C, 3 CP;		gemäß § 2 Absatz 1, 3 CP		30
	2. Sem.	Introduction A, 6 CP; Advanced Studies A, 6 CP; Additional Studies A, 3 CP	Introduction B, 6 CP; Advanced Studies B, 6 CP; Additional Studies B, 3 CP	Introduction C, 6 CP; Advanced Studies C, 6 CP; Additional Studies C, 3 CP		gemäß § 2 Absatz 1, 3 CP		30
2. Jahr	3. Sem.				gemäß Anlage 2.2.2: Project Outline, 6 CP; Professional Specialization, 12 CP; Preparatory Project, 12 CP			30
	4. Sem.						MThsPhy, Module Master Thesis (incl. Colloquium), 30 CP	30

CP: Credit Points, Sem.: Semester, incl.: including

Index by areas of study

1) Focus Areas (84 CP)

A total of 84 CP must be acquired. Each Focus Area consists of the thematic fields Fundamentals (18 CP) and Specialization (30 CP).

a) Fundamentals (54 CP)

Fundamentals totaling 54 CP must be completed in three Focus Areas.

aa) Computational Physics (18 CP)

01-PHY-MA-CP-ResLab: Computational Physics – Research Lab (3 CP).....	6
01-PHY-MA-CP-Intro: Computational Physics – Introduction (6 CP).....	8
01-PHY-MA-CP-Adv: Computational Physics – Advanced Studies (6 CP).....	12
01-PHY-MA-CP-Add: Computational Physics – Additional Studies (3 CP).....	16

bb) Environmental Physics (18 CP)

01-PHY-MA-EP-ResLab: Environmental Physics - Research Lab (3 CP).....	20
01-PHY-MA-EP-Intro: Environmental Physics - Introduction (6 CP).....	22
01-PHY-MA-EP-Adv: Environmental Physics - Advanced Studies (6 CP).....	26
01-PHY-MA-EP-Add: Environmental Physics - Additional Studies (3 CP).....	30

cc) Photonics and Physics of Nanostructures (18 CP)

01-PHY-MA-PPN-ResLab: Photonics and Physics of Nanostructures – Research Lab (3 CP).....	34
01-PHY-MA-PPN-Intro: Photonics and Physics of Nanostructures - Introduction (6 CP).....	36
01-PHY-MA-PPN-Adv: Photonics and Physics of Nanostructures – Advanced Studies (6 CP).....	40
01-PHY-MA-PPN-Add: Photonics and Physics of Nanostructures – Additional Studies (3 CP).....	44

dd) Physics of Life (18 CP)

01-PHY-MA-PL-ResLab: Physics of Life – Research Lab (3 CP).....	48
01-PHY-MA-PL-Intro: Physics of Life - Introduction (6 CP).....	50
01-PHY-MA-PL-Adv: Physics of Life – Advanced Studies (6 CP).....	54
01-PHY-MA-PL-Add: Physics of Life – Additional Studies (3 CP).....	58

ee) Physics of the Universe (18 CP)

01-PHY-MA-PU-ResLab: Physics of the Universe – Research Lab (3 CP).....	62
01-PHY-MA-PU-Intro: Physics of the Universe – Introduction (6 CP).....	64
01-PHY-MA-PU-Adv: Physics of the Universe – Advanced Studies (6 CP).....	68
01-PHY-MA-PU-Add: Physics of the Universe – Additional Studies (3 CP).....	72

ff) Theoretical Physics (18 CP)

01-PHY-MA-TP-ResLab: Theoretical Physics – Research Lab (3 CP).....	76
01-PHY-MA-TP-Intro: Theoretical Physics - Introduction (6 CP).....	78
01-PHY-MA-TP-Adv: Theoretical Physics – Advanced Studies (6 CP).....	82
01-PHY-MA-TP-Add: Theoretical Physics – Additional Studies (3 CP).....	86

b) Specialization (30 CP)

The modules of the Specialization must be completed in one of the accomplished Foundations.

aa) Computational Physics (30 CP)

01-PHY-MA-CP-ProOt: Computational Physics - Project Outline (6 CP).....	4
01-PHY-MA-CP-ProSp: Computational Physics - Professional Specialisation (12 CP).....	10
01-PHY-MA-CP-PrePro: Computational Physics - Preparatory Project (12 CP).....	14

bb) Environmental Physics (30 CP)

01-PHY-MA-EP-ProOt: Environmental Physics - Project Outline (6 CP).....	18
01-PHY-MA-EP-ProSp: Environmental Physics -Professional Specialization (12 CP).....	24
01-PHY-MA-EP-PrePro: Environmental Physics - Preparatory Project (12 CP).....	28

cc) Photonics and Physics of Nanostructures (30 CP)

01-PHY-MA-PPN-ProOt: Photonics and Physics of Nanostructures - Project Outline (6 CP).....	32
01-PHY-MA-PPN-ProSp: Photonics and Physics of Nanostructures - Professional Specialization (12 CP).....	38
01-PHY-MA-PPN-PrePro: Photonics and Physics of Nanostructures - Preparatory Project (12 CP).....	42

dd) Physics of Life (30 CP)

01-PHY-MA-PL-ProOt: Physics of Life - Project Outline (6 CP).....	46
01-PHY-MA-PL-ProSp: Physics of Life - Professional Specialization (12 CP).....	52
01-PHY-MA-PL-PrePro: Physics of Life - Preparatory Project (12 CP).....	56

ee) Physics of the Universe (30 CP)

01-PHY-MA-PU-ProOt: Physics of the Universe - Project Outline (6 CP).....	60
01-PHY-MA-PU-ProSp: Physics of the Universe -Professional Specialization (12 CP).....	66
01-PHY-MA-PU-PrePro: Physics of the Universe - Preparatory Project (12 CP).....	70

ff) Theoretical Physics (30 CP)

01-PHY-MA-TP-ProOt: Theoretical Physics - Project Outline (6 CP).....	74
01-PHY-MA-TP-ProSp: Theoretical Physics - Professional Specialization (12 CP).....	80
01-PHY-MA-TP-PrePro: Theoretical Physics - Preparatory Project (12 CP).....	84

2) General Studies (6 CP)

The General Studies area comprises 6 CP. Credit points in this elective area can be acquired in the supplementary studies of the University of Bremen or in the following modules.

01-PHY-MA-SIP1: Symbiotic Interdisciplinary Projects 1 (3 CP).....	88
01-PHY-MA-SIP2: Symbiotic Interdisciplinary Projects 2 (3 CP).....	90

3) Master Thesis (30 CP)

01-PHY-MA-MThsPhy: Master Thesis including Colloquium (30 CP).....	92
--	----

4) Additional Courses

01-PHY-MA-0: Ergänzende Veranstaltungen im Master Physik (NaN CP).....	94
--	----

Module 01-PHY-MA-CP-ProOt: Computational Physics - Project Outline

Computational Physics - Project Outline

Assignment to areas of study:

- Focus Areas / Specialization / Computational Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

During the project outline, initial ideas for the preparatory project are developed and summarised. The knowledge needed for the corresponding research (e.g. software, etc.) started to be acquired.

Learning outcomes / competencies / targeted competencies:

Formulation of a scientific question to be worked on following the preparatory project. This question is summarised accordingly so that the planning of the preparatory project can begin.

Calculation of student workload:

180 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Vasily Ploshikhin

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Computational Physics - Project Outline

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Computational Physics - Project Outline

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-CP-ResLab: Computational Physics – Research Lab Computational Physics – Research Lab

Assignment to areas of study:

- Focus Areas / Fundamentals / Computational Physics

Content-related prior knowledge or skills:

Bachelor Physics

Learning content:

Planning, realization, documentation and presentation of a scientific project. The project content consists of three main elements: physical modelling, numerical methods and programming techniques. The aim is to teach students the three above-mentioned aspects of computational physics as part of a holistic solution to a complex physical problem.

Research Lab physics-based Simulation

The project task consists of developing a physics-based model (a digital twin) for the thermal simulation of a 3D printing process (e.g., selective laser melting).

Key content:

- Modelling of the thermal 3D printing process
- Analysis of transient temperature development as a function of process parameters, material properties, and the design of the generated component
- Identification of thermally critical areas (overheated areas)
- Simulation-based development of measures to prevent thermal overheating

Computational Neuroscience Research Lab

Two-week block course in data analysis and modelling, with particular focus on neural systems.

Basic knowledge in Python required:

- advanced programming concepts (OOP, debugging, parallelization)
- analysis of biosignals (filters, spectral analysis, dimensionality reduction, coding/classification)
- numerical mathematics (integration, differentiation, solving differential equations, optimization)
- modelling and simulation (circuits, neurons, networks)

Learning outcomes / competencies / targeted competencies:

Practical experience in planning, realization, documentation and presentation of a scientific project in the field of computational physics.

Calculation of student workload:

58 h Preparation / follow-up work

32 h SWS / presence time / working hours

Are there optional courses in the modules?

yes

- Research Lab "Physics-based Simulation" (winter semester) – 3 CP
- Computational Neuroscience Research Lab (winter semester) – 3 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Vasily Ploshikhin

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!**Module examinations****Module examination:** Studienleistung Research Lab**Type of examination:** module exam**Form of examination:**

Internship report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses**Course:** Computational Physics - Research Lab**Frequency:**

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

-

Teaching format(s):

Laboratory class

Associated module examination:

Studienleistung Research Lab

Module 01-PHY-MA-CP-Intro: Computational Physics – Introduction

Computational Physics – Introduction

Assignment to areas of study:

- Focus Areas / Fundamentals / Computational Physics

Content-related prior knowledge or skills:

Bachelor Physics

Learning content:

The lecture provides an overview of the most important numerical methods, algorithms, and software techniques for the computational solution of complex problems at the interface between physics, engineering, and materials science.

The lecture is primarily aimed at physics students interested in the practical application of physical modelling in modern industries such as aerospace, energy, microelectronics and medicine.

Key contents:

- Introduction to the most important numerical methods (finite differences, finite volumes, finite elements);
- Detailed consideration of the finite element method (FEM);
- Learning how to use the commercial FEM simulation software ABAQUS;
- Derivation of analytical solutions to partial differential equations and comparison of analytical results with results of numerical simulation;
- Individual project work on the practical application of numerical simulation to solve a complex, industry-relevant problem.

Learning outcomes / competencies / targeted competencies:

- Understanding of the basic concepts and methods of computational physics.
- Understanding of the possible applications of numerical methods to complex systems in the fields of general physics, engineering and materials science.

Calculation of student workload:

56 h SWS / presence time / working hours

54 h Exam preparation

70 h Preparation / follow-up work

Are there optional courses in the modules?

yes

- Computational Methods in Physics, Engineering and Materials Science (with exercises) – 6 CP
- Theoretical Physics of Life (with exercises) – 6 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Vasily Ploshikhin

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Computational Physics - Introduction

Type of examination: module exam

Form of examination:

Written examination

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Computational Physics - Introduction

Frequency:

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Tutorial

Associated module examination:

Prüfungsleistung Computational Physics -

Introduction

Module 01-PHY-MA-CP-ProSp: Computational Physics - Professional Specialization Computational Physics - Professional Specialisation

Assignment to areas of study:

- Focus Areas / Specialization / Computational Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

This module summarises the in-depth familiarisation with the specific physical principles relevant to the topic of the research phase. The basic techniques and models of the respective research area are studied. This includes both literature study and practical activities in the laboratory, in the sense of an advanced laboratory internship or computer internship. The module is usually worked on in one of the specialisations offered in Faculty 1. During this module, the students are continuously supervised by university lecturers and scientific staff of the respective research group. The contents result from one of the 6 specialisations in which the thesis is located: Computational Physics

Learning outcomes / competencies / targeted competencies:

Knowledge and understanding of the task-specific physical basics, recognition of the relation to the relationship to related fields and the ability to present this knowledge in writing and orally and to use it for one's own research, to present this knowledge in writing and orally and to use it for own research.

Calculation of student workload:

242 h Preparation / follow-up work

28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Vasily Ploshikhin

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Computational Physics - Professional Specialization

Type of examination: module exam

Form of examination:

Presentation, oral

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Computational Physics - Professional Specialisation

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Seminar

Associated module examination:

Module 01-PHY-MA-CP-Adv: Computational Physics – Advanced Studies Computational Physics – Advanced Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Computational Physics

Content-related prior knowledge or skills:

Bachelor Physics

Learning content:

Key content:

- Overview of the use of physics-based simulation for the development and optimization of innovative computer-aided production processes in modern industries (primary and forming processes, cutting and joining processes, laser material processing and 3D printing).
- Fundamentals of heat transfer and solid mechanics with regard to numerical simulation.
- Digital twins, process and material models.
- Particularities of changes in material properties under complex thermomechanical process conditions; the formation of distortion and residual stresses; pore and crack formation mechanisms.
- Learning how to use the commercial FEM simulation software ABAQUS.
- Individual project work on the practical application of FEM simulation to solve a complex, industry-relevant problem in the field of laser material processing or 3D printing.

Learning outcomes / competencies / targeted competencies:

- Concepts and methods of physics-based modeling and simulation, as well as the efficient solution of complex application-oriented problems.
- Mastery of modern software tools for modeling and simulating complex physical processes.

Calculation of student workload:

56 h SWS / presence time / working hours

54 h Exam preparation

70 h Preparation / follow-up work

Are there optional courses in the modules?

yes

- Macroscopic Modelling and physics-based Simulation (with exercises) – 6 CP
- Theory of Complex Systems (with exercises) - 6 CP
- Theoretical Neurophysics (with exercises) - 6 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Vasily Ploshikhin

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Computational Physics – Advanced Studies

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Computational Physics – Advanced Studies

Frequency:

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Lecture

Associated module examination:

Prüfungsleistung Computational Physics – Advanced Studies

Module 01-PHY-MA-CP-PrePro: Computational Physics - Preparatory Project

Computational Physics - Preparatory Project

Assignment to areas of study:

- Focus Areas / Specialization / Computational Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

The skills of experimental or theoretical-mathematical practice are acquired in the preparatory project, which are the prerequisite for carrying out the research project within the framework of the Master's thesis. This preparatory project is usually written in one of the specialisations offered in Faculty 1. The work is carried out usually in the laboratories of the research institutes of Faculty 1 under individual guidance (project internship). At the end, a concept paper on a possible research project is written. This paper should usually correspond to the research programme for the upcoming research project of the Master's thesis.

Learning outcomes / competencies / targeted competencies:

- Transferring a scientific question into an experimental and/or theoretical investigation,
- successful strategies in planning and conducting scientific investigations,
- Ability to critically evaluate, classify and discuss own scientific results,
- summarise and present results in a report

Calculation of student workload:

360 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Vasily Ploshikhin

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Computational Physics - Preparatory Project

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Computational Physics - Preparatory Project

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-CP-Add: Computational Physics – Additional Studies

Computational Physics – Additional Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Computational Physics

Content-related prior knowledge or skills:

Bachelor Physics

Learning content:

The lecture provides an overview of specialized numerical methods and software for physics-based modeling and simulation. Due to their efficiency, the methods discussed are increasingly being used in many industries, such as aerospace, energy, microelectronics, and medicine. They are used to develop and optimize modern production processes.

Core content:

- Thermal simulations: Conventional simulation and thermal process management, multiscale thermal simulations, accelerated thermal simulation approaches and methods for monitoring thermal processes
- Thermomechanical simulation: Conventional simulation, inherent strain method for accelerated simulation and hybrid method for accelerated thermomechanical simulation
- Microstructure simulation: Cellular automata method, coupled thermal and microstructure simulation
- Individual project work on the practical application of simulation to solve a complex, industry-relevant problem.

Learning outcomes / competencies / targeted competencies:

Knowledge of modern concepts for the application of numerical methods and independent modelling and simulation of complex physical systems.

Calculation of student workload:

28 h Exam preparation

28 h SWS / presence time / working hours

34 h Preparation / follow-up work

Are there optional courses in the modules?

yes

- Advanced physics-based Modelling and Simulation - 3 CP
- Advanced Scientific Programming - 3 CP
- Numerical Mathematics - 3 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Vasily Ploshikhin

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Computational Physics – Additional Studies

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Computational Physics – Additional Studies

Frequency:

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

2,00

Additional comments:

Lernziele de

Teaching format(s):

Lecture

Tutorial

Seminar

Associated module examination:

Studienleistung Computational Physics – Additional Studies

Module 01-PHY-MA-EP-ProOt: Environmental Physics - Project Outline

Environmental Physics - Project Outline

Assignment to areas of study:

- Focus Areas / Specialization / Environmental Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

During the project outline, initial ideas for the preparatory project are developed and summarised. The knowledge needed for the corresponding research (e.g. software, etc.) started to be acquired.

Learning outcomes / competencies / targeted competencies:

Formulation of a scientific question to be worked on following the preparatory project. This question is summarised accordingly so that the planning of the preparatory project can begin.

Calculation of student workload:

180 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Hartmut Bösch

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Environmental Physics - Project Outline

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Environmental Physics - Project Outline

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-EP-ResLab: Environmental Physics - Research Lab

Environmental Physics - Research Lab

Assignment to areas of study:

- Focus Areas / Fundamentals / Environmental Physics

Content-related prior knowledge or skills:

No formal requirements

Learning content:

A set of practical experiments on atmospheric trace gases, ocean currents, the earth's surface, ice thickness and numerical modelling of transport and chemistry of the atmosphere using different techniques is performed by the students under supervision of tutors. The results obtained in the lab will then be analysed, and the experiment, its background and the results as well as their interpretation be documented in a written report. The available topics will be presented at the beginning of semester. Students form groups of two and choose two experiments which they perform on assigned days.

Learning outcomes / competencies / targeted competencies:

Participants learn to perform measurements and modelling central to Environmental Physics using scientific techniques and methods. They learn to analyse the measurements and to document the results in a written report. Self-exploration of new topics and team work is needed and practiced.

Calculation of student workload:

32 h SWS / presence time / working hours

58 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

PD Dr. Andreas Richter

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Environmental Physics - Research Lab**Type of examination:** module exam**Form of examination:**

Internship report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Environmental Physics - Research Lab

Frequency:
each semester

Contact hours:
2,00

Teaching format(s):
Laboratory class

Language(s) of instruction:
English

Associated module examination:
Studienleistung Environmental Physics - Research
Lab

Module 01-PHY-MA-EP-Intro: Environmental Physics - Introduction

Environmental Physics - Introduction

Assignment to areas of study:

- Focus Areas / Fundamentals / Environmental Physics

Content-related prior knowledge or skills:

No formal requirements

Learning content:

The introduction provides

- information about the origin of the solar system and the earth's atmosphere and ocean
- the physical parameters, which determine the conditions in the atmosphere and ocean
- the physical laws, which describe electromagnetic radiation
- the interaction between electromagnetic radiation and matter
- atmospheric radiative transport
- radiation balance, climate change
- an introduction into dynamical processes

Learning outcomes / competencies / targeted competencies:

An adequate understanding of the fundamentals of atmospheric physics.

This addresses

- a) gaining an understanding of the laws of physics, which determine the behaviour of the earth system, which comprises the sun, the atmosphere, the ocean and earth surface
- b) learning the ability to apply the laws of physics to calculate parameters and forecast conditions in the atmosphere.

Calculation of student workload:

56 h Preparation / follow-up work

68 h Exam preparation

56 h SWS / presence time / working hours

Are there optional courses in the modules?

yes

- Atmospheric Physics (6cp)
- Dynamics I (6cp)
- Physical Oceanography I (6cp)

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Hartmut Bösch

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Environmental Physics - Introduction

Type of examination: module exam

Form of examination:

Written examination

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Environmental Physics - Introduction

Frequency:

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Tutorial

Associated module examination:

Prüfungsleistung Environmental Physics -

Introduction

Module 01-PHY-MA-EP-ProSp: Environmental Physics - Professional Specialization Environmental Physics -Professional Specialization

Assignment to areas of study:

- Focus Areas / Specialization / Environmental Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

This module summarises the in-depth familiarisation with the specific physical principles relevant to the topic of the research phase. The basic techniques and models of the respective research area are studied. This includes both literature study and practical activities in the laboratory, in the sense of an advanced laboratory internship or computer internship. The module is usually worked on in one of the specialisations offered in Faculty 1. During this module, the students are continuously supervised by university lecturers and scientific staff of the respective research group. During this module, students are continuously supervised by university lecturers and research assistants of the respective working group. The contents result from one of the 6 specialisations in which the thesis is located: Environmental Physics.

Learning outcomes / competencies / targeted competencies:

Knowledge and understanding of the task-specific physical basics, recognition of the relation to the relationship to related fields and the ability to present this knowledge in writing and orally and to use it for one's own research, to present this knowledge in writing and orally and to use it for own research.

Calculation of student workload:

28 h SWS / presence time / working hours

242 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Hartmut Bösch

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Environmental Physics - Professional Specialization

Type of examination: module exam

Form of examination:

Presentation, oral

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Environmental Physics -Professional Specialization

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Seminar

Laboratory class

Associated module examination:

Module 01-PHY-MA-EP-Adv: Environmental Physics - Advanced Studies

Environmental Physics - Advanced Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Environmental Physics

Content-related prior knowledge or skills:

No formal requirements

Learning content:

The advanced course provides information about the remote sensing, the climate system and molecular spectroscopy.

Learning outcomes / competencies / targeted competencies:

An adequate understanding of the fundamentals of remote sensing, spectroscopy and climate system.

Calculation of student workload:

56 h Preparation / follow-up work

56 h SWS / presence time / working hours

68 h Exam preparation

Are there optional courses in the modules?

yes

- Climate System (3cp)
- Remote Sensing (3cp)
- Atmospheric Spectroscopy (3cp)

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer.nat. Justus Notholt

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Environmental Physics - Advanced Studies

Type of examination: module exam

Form of examination:

Written examination

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Description:

written examination + oral examination

Module courses

Course: Environmental Physics - Advanced Studies

Frequency:

summer semester, yearly

Contact hours:

4,00

Teaching format(s):

Lecture

Tutorial

Language(s) of instruction:

English

Associated module examination:

Prüfungsleistung Environmental Physics - Advanced Studies

Module 01-PHY-MA-EP-PrePro: Environmental Physics - Preparatory Project

Environmental Physics - Preparatory Project

Assignment to areas of study:

- Focus Areas / Specialization / Environmental Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

Skills of experimental or theoretical-mathematical practice are acquired in the preparatory project, which are the prerequisite for carrying out the research project within the framework of the Master's thesis. This preparatory project is usually written in one of the specialisations offered in Faculty 1. The work is carried out usually in the laboratories of the research institutes of Faculty 1 under individual guidance (project internship). At the end, a concept paper on a possible research project is written. This paper should usually correspond to the research programme for the upcoming research project of the Master's thesis.

Learning outcomes / competencies / targeted competencies:

- Transferring a scientific question into an experimental and/or theoretical investigation
- successful strategies in planning and conducting scientific investigations
- Ability to critically evaluate, classify and discuss own scientific results
- summarise and present results in a report

Calculation of student workload:

360 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Hartmut Bösch

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Environmental Physics - Preparatory Project

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Environmental Physics - Preparatory Project

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-EP-Add: Environmental Physics - Additional Studies

Environmental Physics - Additional Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Environmental Physics

Content-related prior knowledge or skills:

No formal requirements

Learning content:

The elective courses provide information about e.g. the carbon cycle, biogeochemical cycles and modelling.

Learning outcomes / competencies / targeted competencies:

An adequate understanding of advanced knowledge on carbon cycle, biogeochemical cycles and modelling.

Calculation of student workload:

34 h Exam preparation

28 h SWS / presence time / working hours

28 h Preparation / follow-up work

Are there optional courses in the modules?

yes

- Atmospheric Chemistry Modelling: Part I (Theory) (3cp)
- Global Carbon Cycle (3cp)

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Annette Ladstätter-Weißmayer

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Environmental Physics - Additional Studies

Type of examination: module exam

Form of examination:

Presentation and written assignment

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Environmental Physics - Additional Studies

Frequency:
each semester

Contact hours:
2,00

Teaching format(s):
Lecture

Language(s) of instruction:
English

Associated module examination:
Studienleistung Environmental Physics - Additional
Studies

Module 01-PHY-MA-PPN-ProOt: Photonics and Physics of Nanostructures - Project Outline

Photonics and Physics of Nanostructures - Project Outline

Assignment to areas of study:

- Focus Areas / Specialization / Photonics and Physics of Nanostructures

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

During the project outline, initial ideas for the preparatory project are developed and summarised. The knowledge needed for the corresponding research (e.g. software, etc.) started to be acquired.

Learning outcomes / competencies / targeted competencies:

Formulation of a scientific question to be worked on following the preparatory project. This question is summarised accordingly so that the planning of the preparatory project can begin.

Calculation of student workload:

180 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Andreas Rosenauer

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Photonics and Physics of Nanostructures - Project Outline

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Photonics and Physics of Nanostructures - Project Outline

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-PPN-ResLab: Photonics and Physics of Nanostructures – Research Lab

Photonics and Physics of Nanostructures – Research Lab

Assignment to areas of study:

- Focus Areas / Fundamentals / Photonics and Physics of Nanostructures

Content-related prior knowledge or skills:

Bachelor, Solid State Physics, Quantum Mechanics

Learning content:

Two extensive lab experiments using research equipment of the Institute of Solid State Physics. Investigation of nanostructures and low-dimensional systems, respectively. The topics of the experiments will be introduced at the beginning of the lecture period and will be derived from current research topics, with the key aspects

- synthesis of nanostructures
- surface structures and processes at surfaces
- atomic structures and composition
- electronic, optical, and vibronic properties

Learning outcomes / competencies / targeted competencies:

- Self-reliant exploration of topics and techniques.
- Application of complex experimental techniques for the investigation of nanostructures and low-dimensional systems.
- Understanding techniques, their possibilities and limitations.
- Teamwork

Calculation of student workload:

58 h Preparation / follow-up work

32 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Thomas Schmidt

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Photonics and Physics of Nanostructures – Research Lab

Type of examination: module exam

Form of examination:

Internship report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Photonics and Physics of Nanostructures – Research Lab

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Additional comments:

Lernziele de

Teaching format(s):

Laboratory class

Associated module examination:

Studienleistung Photonics and Physics of Nanostructures – Research Lab

Module 01-PHY-MA-PPN-Intro: Photonics and Physics of Nanostructures - Introduction

Photonics and Physics of Nanostructures - Introduction

Assignment to areas of study:

- Focus Areas / Fundamentals / Photonics and Physics of Nanostructures

Content-related prior knowledge or skills:

Solid State Physics, Quantum Mechanics

Learning content:

Optional introduction to the *Physics of Nanostructures* in the context of Experimental or Theoretical Physics or *Fundamentals of Optics and Photonics*

Learning outcomes / competencies / targeted competencies:

Understanding of the physical principles of low-dimensional systems, their application in quantum technology, as well as the principles and realizations of modern optical, photonic, and optoelectronic systems.

Calculation of student workload:

70 h Preparation / follow-up work

56 h SWS / presence time / working hours

54 h Exam preparation

Are there optional courses in the modules?

yes

- Physics of Nanostructures: From Atoms to Quantum Technology 6 CP
- Theoretical Solid State Physics - From fundamental interactions to nanostructures 6 CP
- Optics and Photonics - Basics and Applications 6 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Gordon Jens Callsen

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Photonics and Physics of Nanostructures - Introduction

Type of examination: module exam

Form of examination:

Oral examination (single)

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Photonics and Physics of Nanostructures - Introduction

Frequency:

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Associated module examination:

Prüfungsleistung Photonics and Physics of Nanostructures - Introduction

Module 01-PHY-MA-PPN-ProSp: Photonics and Physics of Nanostructures - Professional Specialization

Photonics and Physics of Nanostructures - Professional Specialization

Assignment to areas of study:

- Focus Areas / Specialization / Photonics and Physics of Nanostructures

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

This module summarises the in-depth familiarisation with the specific physical principles relevant to the topic of the research phase. The basic techniques and models of the respective research area are studied. This includes both literature study and practical activities in the laboratory, in the sense of an advanced laboratory internship or computer internship. The module is usually worked on in one of the specialisations offered in Faculty 1. During this module, the students are continuously supervised by university lecturers and scientific staff of the respective research group. During this module, students are continuously supervised by university lecturers and research assistants of the respective working group. The contents result from one of the 6 specialisations in which the thesis is located: Photonics and Physics of Nanostructures

Learning outcomes / competencies / targeted competencies:

Knowledge and understanding of the task-specific physical basics, recognition of the relation to the relationship to related fields and the ability to present this knowledge in writing and orally and to use it for one's own research, to present this knowledge in writing and orally and to use it for own research.

Calculation of student workload:

242 h Preparation / follow-up work

28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Martin Eickhoff

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Photonics and Physics of Nanostructures - Professional Specialization

Type of examination: module exam

Form of examination:

Presentation, oral

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Photonics and Physics of Nanostructures - Professional Specialization

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Additional comments:

0

Teaching format(s):

Seminar

Laboratory class

Associated module examination:

Module 01-PHY-MA-PPN-Adv: Photonics and Physics of Nanostructures – Advanced Studies

Photonics and Physics of Nanostructures – Advanced Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Photonics and Physics of Nanostructures

Content-related prior knowledge or skills:

Solid State Physics, Quantum Mechanics

Learning content:

Experimental Physics

Solid-state Materials: methods of synthesizing semiconductor nanostructures, electronic properties, application in optoelectronic components, nanosensors

Transmission Electron Microscopy: construction of the transmission electron microscope (TEM), fundamentals of imaging, kinematic and dynamic electron diffraction, high-resolution imaging, lens aberrations and incoherence effects, scanning TEM, "frozen lattice" and absorptive potential methods.

Semiconductor Optics: non-linear dielectric function, frequency multiplication and mixing, Raman spectroscopy and thermometry, population-induced optical and thermal nonlinearities, charge carrier dynamics in semiconductors, dephasing processes, pump-probe spectroscopy

Surface Physics: Structure of two-dimensional (2D) systems and surfaces, 2D reciprocal space, scanning probe microscopy, diffraction on 2D systems, microscopy with low-energy electrons, chemical characterization with photoelectron spectroscopy.

Theory

Introduction to the diagram technique (propagators and time-ordered Green's function, Dirac picture, S operators, Gell-Mann and Low theorem, Wick theorem, Feynman diagrams, Dyson equation), Schwinger-Keldysh-Technique for nonequilibrium systems (external perturbation, double-time contour, equations of motion), applications

Learning outcomes / competencies / targeted competencies:

Concepts of advanced experimental physics of nanostructures from the areas of transmission electron microscopy, semiconductor optics, solid-state materials and surface physics, or concepts of modern many-body physics.

Calculation of student workload:

70 h Preparation / follow-up work

56 h SWS / presence time / working hours

54 h Exam preparation

Are there optional courses in the modules?

yes

- Experimental Physics of Nanostructures 6 CP
- Introduction to Feynman Diagrams and Quantum Field Theory with Applications to Solid State Physics 6 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Andreas Rosenauer

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations**Module examination:** Prüfungsleistung Photonics and Physics of Nanostructures – Advanced Studies**Type of examination:** module exam**Form of examination:**

Oral examination (single)

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses**Course:** Photonics and Physics of Nanostructures – Advanced Studies**Frequency:**

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Associated module examination:

Prüfungsleistung Photonics and Physics of Nanostructures – Advanced Studies

Module 01-PHY-MA-PPN-PrePro: Photonics and Physics of Nanostructures - Preparatory Project

Photonics and Physics of Nanostructures - Preparatory Project

Assignment to areas of study:

- Focus Areas / Specialization / Photonics and Physics of Nanostructures

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

The skills of experimental or theoretical-mathematical practice are acquired in the preparatory project, which are the prerequisite for carrying out the research project within the framework of the Master's thesis. This preparatory project is usually written in one of the specialisations offered in Faculty 1. The work is carried out usually in the laboratories of the research institutes of Faculty 1 under individual guidance (project internship). At the end, a concept paper on a possible research project is written. This paper should usually correspond to the research programme for the upcoming research project of the Master's thesis.

Learning outcomes / competencies / targeted competencies:

- Transferring a scientific question into an experimental and/or theoretical investigation,
- successful strategies in planning and conducting scientific investigations,
- Ability to critically evaluate, classify and discuss own scientific results,
- summarise and present results in a report

Calculation of student workload:

360 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Andreas Rosenauer

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Photonics and Physics of Nanostructures - Preparatory Project

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Photonics and Physics of Nanostructures - Preparatory Project

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
-

Teaching format(s):
Project

Associated module examination:

Module 01-PHY-MA-PPN-Add: Photonics and Physics of Nanostructures – Additional Studies

Photonics and Physics of Nanostructures – Additional Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Photonics and Physics of Nanostructures

Content-related prior knowledge or skills:

Solid State Physics, Quantum Mechanics

Learning content:

In addition to the learning content of the PPN-Intro or PPN-Adv modules, there are additional and more in-depth topics from the areas of experimental or theoretical nanostructure physics or laser physics and photonic systems in the form of a lecture, a seminar or an exercise.

Learning outcomes / competencies / targeted competencies:

Concepts and knowledge of modern applications in the fields of surface physics, semiconductor optics, transmission electron microscopy, solid-state materials and theoretical solid-state physics as well as laser physics and photonic systems.

Calculation of student workload:

28 h Exam preparation

28 h SWS / presence time / working hours

34 h Preparation / follow-up work

Are there optional courses in the modules?

yes

- Synchrotron Radiation: Basics and Applications of Nanostructures 3 CP
- Modern Semiconductor Physics – Concepts and Devices 3 CP
- Modern topics in Nanostructure Physics – Seminar 3 CP
- Lasers and Photonic Systems – Lecture 3 CP
- Lasers and Photonic Systems – Seminar 3 CP
- Theoretical Solid State Physics – Exercises 3 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Martin Eickhoff

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Photonics and Physics of Nanostructures – Additional Studies

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Photonics and Physics of Nanostructures – Additional Studies

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Lecture

Tutorial

Seminar

Associated module examination:

Studienleistung Photonics and Physics of
Nanostructures – Additional Studies

Module 01-PHY-MA-PL-ProOt: Physics of Life - Project Outline

Physics of Life - Project Outline

Assignment to areas of study:

- Focus Areas / Specialization / Physics of Life

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

During the project outline, initial ideas for the preparatory project are developed and summarised. The knowledge needed for the corresponding research (e.g. software, etc.) started to be acquired.

Learning outcomes / competencies / targeted competencies:

Formulation of a scientific question to be worked on following the preparatory project. This question is summarised accordingly so that the planning of the preparatory project can begin.

Calculation of student workload:

180 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Manfred Radmacher

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of Life - Project Outline

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of Life - Project Outline

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-PL-ResLab: Physics of Life – Research Lab

Physics of Life – Research Lab

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of Life

Content-related prior knowledge or skills:

Bachelor, Biophysics

Learning content:

a) Experimental Research Lab

- preparation of cells
- preparation of soft polymer gels as and support for cell culture
- investigation of cells using light and force microscopy
- characterization of migratory and mechanical properties of cells

b) Computational Neuroscience Research Lab

Two-week block course in data analysis and modelling, with particular focus on neural systems. Basic knowledge in Python required:

- advanced programming concepts (OOP, debugging, parallelization)
- analysis of biosignals (filters, spectral analysis, dimensionality reduction, coding/classification)
- numerical mathematics (integration, differentiation, solving differential equations, optimization)
- modelling and simulation (circuits, neurons, networks)

Learning outcomes / competencies / targeted competencies:

- Self-reliant exploration of topics and techniques.
- Application of complex experimental techniques for the investigation of biological systems.
- Understanding techniques, their possibilities and limitations.
- Teamwork

Calculation of student workload:

58 h Preparation / follow-up work

32 h SWS / presence time / working hours

Are there optional courses in the modules?

yes

- Experimental Research Lab (3cp)
- Computational Neuroscience Research Lab (3cp)

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Manfred Radmacher

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of Life – Research Lab

Type of examination: module exam

Form of examination:

Internship report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of Life – Research Lab

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Laboratory class

Associated module examination:

Studienleistung Physics of Life – Research Lab

Module 01-PHY-MA-PL-Intro: Physics of Life - Introduction

Physics of Life - Introduction

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of Life

Content-related prior knowledge or skills:

Bachelor: Compulsory elective module Biophysics

Learning content:

This module introduces in the concepts from physics, which allow to describe living systems:

- weak interaction forces in protein structure formation, forming of molecular aggregates (polymers and cellular compartments), interaction between cells and formation of tissue-like
- physics in molecular machines: motor enzymes, sensory apparatus, photosynthesis, membrane potentials
- theoretical concepts for non-linear and non-equilibrium systems: pattern formation in space and time, neuronal networks and machine learning

The module consists of the following compulsory courses:

- Experimental Physics of Life (Lecture, 3 CP)
- Theoretical Physics of Life (Lecture, 3 CP)

Learning outcomes / competencies / targeted competencies:

Introduction in principle of physics found in biological systems, organization and structure of biological systems and methods to investigate biological systems.

Calculation of student workload:

54 h Exam preparation

56 h SWS / presence time / working hours

70 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Manfred Radmacher

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Physics of Life - Introduction

Type of examination: module exam

Form of examination:

Oral examination (single)

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Physics of Life - Introduction

Frequency:

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Associated module examination:

Prüfungsleistung Physics of Life - Introduction

Module 01-PHY-MA-PL-ProSp: Physics of Life - Professional Specialization

Physics of Life - Professional Specialization

Assignment to areas of study:

- Focus Areas / Specialization / Physics of Life

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

This module summarises the in-depth familiarisation with the specific physical principles relevant to the topic of the research phase. The basic techniques and models of the respective research area are studied. This includes both literature study and practical activities in the laboratory, in the sense of an advanced laboratory internship or computer internship. The module is usually worked on in one of the specialisations offered in Faculty 1. During this module, the students are continuously supervised by university lecturers and scientific staff of the respective research group. During this module, students are continuously supervised by university lecturers and research assistants of the respective working group. The contents result from one of the 6 specialisations in which the thesis is located: Physics of Life

Learning outcomes / competencies / targeted competencies:

Knowledge and understanding of the task-specific physical basics, recognition of the relation to the relationship to related fields and the ability to present this knowledge in writing and orally and to use it for one's own research, to present this knowledge in writing and orally and to use it for own research.

Calculation of student workload:

242 h Preparation / follow-up work

28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Manfred Radmacher

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of Life - Professional Specialization

Type of examination: module exam

Form of examination:

Presentation, oral

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of Life - Professional Specialization

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Seminar
Laboratory class

Associated module examination:

Module 01-PHY-MA-PL-Adv: Physics of Life – Advanced Studies

Physics of Life – Advanced Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of Life

Content-related prior knowledge or skills:

Physics of Life - Introduction

Learning content:

Advanced Experimental Physics of Life

- Mechanics of Cells and Tissues: Structure of tissues and the extracellular matrix,
- Physics of polymers, Rheology
- Microscopy for Physics of Life: Optical (including fluorescence and super-resolution) and Force Microscopy

Advanced Theoretical Physics of Life

a) Theoretical Neurophysics:

With its versatile concepts and formal tools, theoretical physics provides the key to a quantitative description of neuronal dynamics and for understanding computation in the brain:

- Fundamental topics: ion channels/neuroelectronics, rate- and spike-based neuron models and networks, synaptic dynamics/transmission, collective dynamics (synchronization, oscillations, avalanches), learning and memory
- Analytical & computational methods: stability analysis, phase transitions, mean-field dynamics, Fokker-Planck formalism, optimization techniques & machine learning, reinforcement and inference schemes

b) Physics of Complex Systems:

The physics of complex systems uses methods from theoretical physics to study phenomena of complex systems in a broad variety of fields, ranging from biology and social systems, to economics and technological systems as the internet, to the origin of life and astrobiology. This lecture will provide an introduction to the physics of complex systems, covering tools and theories such as complex network theory, complex dynamical systems, self-organized criticality, adaptive networks, and evolutionary dynamics.

c) Physics of Socio-Economic Systems:

Socio- and econophysics is a rapidly growing field that uses tools from theoretical physics to model and understand the dynamics of financial markets and human social behavior. This course will provide an introduction to sociophysics and econophysics, covering topics such as economic models, financial risk, social systems, opinion formation, opinion and group dynamics, traffic dynamics, urban systems. Methods range from theoretical physics, as statistical physics and non-linear dynamics, to agent-based modeling, networks, and computational social science.

Learning outcomes / competencies / targeted competencies:

Understanding advanced concepts in experimental or theoretical physics of life, and the ability to use these concepts to study scientific problems in a research context.

Calculation of student workload:

54 h Exam preparation

56 h SWS / presence time / working hours

70 h Preparation / follow-up work

Are there optional courses in the modules?

yes

- Advanced Experimental Physics of Life (6cp)
- Theoretical Neurophysics (6cp)
- Physics of Complex Systems (6cp)
- Physics of Socio-Economic Systems (6cp)

Language(s) of instruction:

English

Frequency:

summer semester, yearly

The module is valid since / The module is valid until:

WiSe 25/26 / -

Responsible for the module:

Prof. Dr. Stefan Bornholdt

Duration:

1 semester[s]

Credit points / Workload:

6 / 180 hours

Module examinations**Module examination:** Prüfungsleistung Physics of Life – Advanced Studies**Type of examination:** module exam**Form of examination:**

Oral examination (single)

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses**Course:** Physics of Life – Advanced Studies**Frequency:**

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Associated module examination:

Prüfungsleistung Physics of Life – Advanced Studies

Module 01-PHY-MA-PL-PrePro: Physics of Life - Preparatory Project

Physics of Life - Preparatory Project

Assignment to areas of study:

- Focus Areas / Specialization / Physics of Life

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

The skills of experimental or theoretical-mathematical practice are acquired in the preparatory project, which are the prerequisite for carrying out the research project within the framework of the Master's thesis. This preparatory project is usually written in one of the specialisations offered in Faculty 1. The work is carried out usually in the laboratories of the research institutes of Faculty 1 under individual guidance (project internship). At the end, a concept paper on a possible research project is written. This paper should usually correspond to the research programme for the upcoming research project of the Master's thesis.

Learning outcomes / competencies / targeted competencies:

- Transferring a scientific question into an experimental and/or theoretical investigation,
- successful strategies in planning and conducting scientific investigations,
- Ability to critically evaluate, classify and discuss own scientific results,
- summarise and present results in a report

Calculation of student workload:

360 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Manfred Radmacher

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of Life - Preparatory Project

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of Life - Preparatory Project

Frequency:
each semester

Contact hours:
-

Teaching format(s):

Language(s) of instruction:
English

Associated module examination:

Module 01-PHY-MA-PL-Add: Physics of Life – Additional Studies

Physics of Life – Additional Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of Life

Content-related prior knowledge or skills:

no formal requirements

Learning content:

In addition to the learning contents of the PL-Intro and PL-Adv modules, there are additional and more in-depth topics from the areas of experimental or theoretical physics of life in the form of a lecture, a seminar or an exercise.

Learning outcomes / competencies / targeted competencies:

Concepts and knowledge of modern applications in the fields of physics of life.

Calculation of student workload:

34 h Preparation / follow-up work

28 h SWS / presence time / working hours

28 h Exam preparation

Are there optional courses in the modules?

yes

- Medical Imaging (Lecture, 3 CP)
- Modern Topics in Physics of Life (Seminar, 3 CP)
- Theoretical Physics of Life (Exercises, 3 CP)

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Hans-Günther Döbereiner

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of Life – Additional Studies

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of Life – Additional Studies

Frequency:
each semester

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial
Seminar

Language(s) of instruction:
English

Associated module examination:
Studienleistung Physics of Life – Additional Studies

Module 01-PHY-MA-PU-ProOt: Physics of the Universe - Project Outline

Physics of the Universe - Project Outline

Assignment to areas of study:

- Focus Areas / Specialization / Physics of the Universe

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

During the project outline, initial ideas for the preparatory project are developed and summarised. The knowledge needed for the corresponding research (e.g. software, etc.) started to be acquired.

Learning outcomes / competencies / targeted competencies:

Formulation of a scientific question to be worked on following the preparatory project. This question is summarised accordingly so that the planning of the preparatory project can begin.

Calculation of student workload:

180 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

PD Dr. Eva Hackmann

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of the Universe - Project Outline

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of the Universe - Project Outline

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-PU-ResLab: Physics of the Universe – Research Lab

Physics of the Universe – Research Lab

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of the Universe

Content-related prior knowledge or skills:

Bachelor's degree in physics, basic knowledge of linear algebra

Learning content:

Research Lab work on space science topics such as

- atom interferometry
- modelling of satellite orbits
- data analysis for experimental tests of gravity

Learning outcomes / competencies / targeted competencies:

Participants learn

- to handle experimental data related to space science and involved technologies,
- to model the experiments using scientific methods,
- to analyze measurements and document results in a written lab report.

Calculation of student workload:

28 h Preparation / follow-up work

34 h Exam preparation

28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

PD Dr. rer. nat. Sven Herrmann

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of the Universe – Research Lab

Type of examination: module exam

Form of examination:

Internship report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of the Universe – Research Lab

Frequency:

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Seminar

Laboratory class

Associated module examination:

Studienleistung Physics of the Universe – Research

Lab

Module 01-PHY-MA-PU-Intro: Physics of the Universe – Introduction

Physics of the Universe – Introduction

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of the Universe

Content-related prior knowledge or skills:

Classical Mechanics, Quantum Mechanics

Learning content:

Optionally introduction to the

- General Relativity
- Celestial mechanics
- Stellar Astrophysics
- Geodesy and Gravity
- Quantum Technologies in Space

Learning outcomes / competencies / targeted competencies:

- Understanding of the physical foundations of (relativistic) gravitational physics and its applications in astrophysics and space science.
- Understanding modern quantum technologies and their applications.

Calculation of student workload:

70 h Preparation / follow-up work

54 h Exam preparation

56 h SWS / presence time / working hours

Are there optional courses in the modules?

yes

- General Relativity (6cp)
- Celestial mechanics (6cp)
- Stellar Astrophysics (6cp)
- Geodesy and Gravity (3cp)
- Quantum Technologies in Space (3cp)

Language(s) of instruction:

English

Responsible for the module:

PD Dr. Eva Hackmann

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Physics of the Universe – Introduction

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Physics of the Universe – Introduction

Frequency:

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Tutorial

Seminar

Associated module examination:

Prüfungsleistung Physics of the Universe –
Introduction

Module 01-PHY-MA-PU-ProSp: Physics of the Universe - Professional Specialization

Physics of the Universe -Professional Specialization

Assignment to areas of study:

- Focus Areas / Specialization / Physics of the Universe

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

This module summarises the in-depth familiarisation with the specific physical principles relevant to the topic of the research phase. The basic techniques and models of the respective research area are studied. This includes both literature study and practical activities in the laboratory, in the sense of an advanced laboratory internship or computer internship. The module is usually worked on in one of the specialisations offered in Faculty 1. During this module, the students are continuously supervised by university lecturers and scientific staff of the respective research group. During this module, students are continuously supervised by university lecturers and research assistants of the respective working group. The contents result from one of the 6 specialisations in which the thesis is located: Physics of the Universe

Learning outcomes / competencies / targeted competencies:

Knowledge and understanding of the task-specific physical basics, recognition of the relation to the relationship to related fields and the ability to present this knowledge in writing and orally and to use it for one's own research, to present this knowledge in writing and orally and to use it for own research.

Calculation of student workload:

28 h SWS / presence time / working hours

242 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

PD Dr. Eva Hackmann

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of the Universe -Professional Specialization

Type of examination: module exam

Form of examination:

Presentation, oral

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of the Universe -Professional Specialization

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Seminar

Laboratory class

Associated module examination:

Module 01-PHY-MA-PU-Adv: Physics of the Universe – Advanced Studies

Physics of the Universe – Advanced Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of the Universe

Content-related prior knowledge or skills:

Electrodynamics, Classical Mechanics, Quantum Mechanics

Learning content:

Optionally applications to experimental tests of General Relativity, Astrophysics, observations of relativistic effects in Astrophysics, Cosmology, Quantum Electrodynamics and the standard model of elementary particles.

Learning outcomes / competencies / targeted competencies:

Deepening of the knowledge in the foundations of General Relativity, Astrophysics and Cosmology as well as in Quantum Field Theory and Particle Physics.

Calculation of student workload:

56 h SWS / presence time / working hours

54 h Exam preparation

70 h Preparation / follow-up work

Are there optional courses in the modules?

yes

- Experimental gravitation (6cp)
- Cosmology (6cp)
- Quantum Electrodynamics (6cp)
- Geometrical Methods in Physics (6cp)
- Seminar: Topics in Gravity and Space (3cp)
- Black Holes (6cp)
- Relativistic Astrophysics (6cp)

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Claus Lämmerzahl

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Physics of the Universe – Advanced Studies

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Physics of the Universe – Advanced Studies

Frequency:

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Tutorial

Seminar

Associated module examination:

Prüfungsleistung Physics of the Universe –
Advanced Studies

Module 01-PHY-MA-PU-PrePro: Physics of the Universe - Preparatory Project

Physics of the Universe - Preparatory Project

Assignment to areas of study:

- Focus Areas / Specialization / Physics of the Universe

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

The skills of experimental or theoretical-mathematical practice are acquired in the preparatory project, which are the prerequisite for carrying out the research project within the framework of the Master's thesis. This preparatory project is usually written in one of the specialisations offered in Faculty 1. The work is carried out usually in the laboratories of the research institutes of faculty 1 under individual guidance (project internship). At the end, a concept paper on a possible research project is written. This paper should usually correspond to the research programme for the upcoming research project of the Master's thesis.

Learning outcomes / competencies / targeted competencies:

- Transferring a scientific question into an experimental and/or theoretical investigation,
- successful strategies in planning and conducting scientific investigations,
- Ability to critically evaluate, classify and discuss own scientific results,
- summarise and present results in a report

Calculation of student workload:

360 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

PD Dr. Eva Hackmann

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of the Universe - Preparatory Project

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of the Universe - Preparatory Project

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-PU-Add: Physics of the Universe – Additional Studies

Physics of the Universe – Additional Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Physics of the Universe

Content-related prior knowledge or skills:

Classical Mechanics, Quantum Mechanics

Learning content:

Optional special topics in General Relativity and applications of Gravitational Physics in Astrophysics and various space projects.

Learning outcomes / competencies / targeted competencies:

Deepening the theoretical and experimental foundations of General Relativity, as well as applications of General Relativity in Astrophysics and space projects.

Calculation of student workload:

28 h Exam preparation

34 h Preparation / follow-up work

28 h SWS / presence time / working hours

Are there optional courses in the modules?

yes

- Science and Exploration Missions (3cp)
- Global Navigation Satellite Systems (3cp)
- General Relativity, Exercises (3cp)
- Fascination Space (seminar) (3cp)

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Claus Lämmerzahl

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Physics of the Universe – Additional Studies

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Physics of the Universe – Additional Studies

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
2,00

Teaching format(s):
Lecture
Tutorial
Seminar

Associated module examination:
Studienleistung Physics of the Universe – Additional
Studies

Module 01-PHY-MA-TP-ProOt: Theoretical Physics - Project Outline

Theoretical Physics - Project Outline

Assignment to areas of study:

- Focus Areas / Specialization / Theoretical Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

During the project outline, initial ideas for the preparatory project are developed and summarised. The knowledge needed for the corresponding research (e.g. software, etc.) started to be acquired.

Learning outcomes / competencies / targeted competencies:

Formulation of a scientific question to be worked on following the preparatory project. This question is summarised accordingly so that the planning of the preparatory project can begin.

Calculation of student workload:

180 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Frank Jahnke

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Theoretical Physics - Project Outline

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Theoretical Physics - Project Outline

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-TP-ResLab: Theoretical Physics – Research Lab

Theoretical Physics – Research Lab

Assignment to areas of study:

- Focus Areas / Fundamentals / Theoretical Physics

Content-related prior knowledge or skills:

Electrodynamics, Quantum Mechanics

Learning content:

Block course for an intensive examination of the application of numerical methods and computer simulations in various areas of theoretical physics:

Numerical Research Lab in Theoretical Solid-State Physics

or

Computational Materials Science Lab

or

Computational Neuroscience Research Lab

Two-week block course in data analysis and modelling, with particular focus on neural systems. Basic knowledge in Python required:

- advanced programming concepts (OOP, debugging, parallelization)
- analysis of biosignals (filters, spectral analysis, dimensionality reduction, coding/classification)
- numerical mathematics (integration, differentiation, solving differential equations, optimization)
- modelling and simulation (circuits, neurons, networks)

Learning outcomes / competencies / targeted competencies:

Familiarization and practical application of numerical methods and programming techniques with increasing complexity and special focus on applications in theoretical physics.

Calculation of student workload:

58 h Preparation / follow-up work

32 h SWS / presence time / working hours

Are there optional courses in the modules?

yes

- Numerical Research Lab in Theoretical Solid-State Physics 3 CP
- Computational Materials Science Lab 3 CP
- Computational Neuroscience Research Lab 3 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Stefan Bornholdt

Frequency:

(depending on capacity) winter or summer semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Theoretical Physics – Research Lab

Type of examination: module exam

Form of examination:

Internship report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Theoretical Physics – Research Lab

Frequency:

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Laboratory class

Associated module examination:

Studienleistung Theoretical Physics – Research Lab

Module 01-PHY-MA-TP-Intro: Theoretical Physics - Introduction

Theoretical Physics - Introduction

Assignment to areas of study:

- Focus Areas / Fundamentals / Theoretical Physics

Content-related prior knowledge or skills:

Electrodynamics, Quantum Mechanics

Learning content:

Introduction to Theoretical Solid-State Physics

or

Relativistic and many-body Quantum Mechanics, Quantum Information Science and Quantum Computer

or

Theoretical Physics of Life

Introduction to methods from theoretical physics for biology and living systems: non-linear dynamics and non-equilibrium statistical mechanics.

Learning outcomes / competencies / targeted competencies:

Understanding the theoretical principles of the above-given learning content, analytical calculation methods, approximation methods and numerical solution techniques, application of theoretical methods to experimental situations.

Calculation of student workload:

70 h Preparation / follow-up work

56 h SWS / presence time / working hours

54 h Exam preparation

Are there optional courses in the modules?

yes

- Theoretical Solid State Physics - From fundamental interactions to nanostructures 6 CP
- Theoretical Physics of Life (with exercises) 6CP
- Relativistische und Vielteilchen-Quantenmechanik, Quanteninformationsverarbeitung und Quantencomputer 6CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Frank Jahnke

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations

Module examination: Prüfungsleistung Theoretical Physics - Introduction

Type of examination: module exam

Form of examination:

Oral examination (single)

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses

Course: Theoretical Physics - Introduction

Frequency:

winter semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Associated module examination:

Prüfungsleistung Theoretical Physics - Introduction

Module 01-PHY-MA-TP-ProSp: Theoretical Physics - Professional Specialization

Theoretical Physics - Professional Specialization

Assignment to areas of study:

- Focus Areas / Specialization / Theoretical Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

This module summarises the in-depth familiarisation with the specific physical principles relevant to the topic of the research phase. The basic techniques and models of the respective research area are studied. This includes both literature study and practical activities in the laboratory, in the sense of an advanced laboratory internship or computer internship. The module is usually worked on in one of the specialisations offered in faculty 1. During this module, the students are continuously supervised by university lecturers and scientific staff of the respective research group. During this module, students are continuously supervised by university lecturers and research assistants of the respective working group. The contents result from one of the 6 specialisations in which the thesis is located: Theoretical Physics

Learning outcomes / competencies / targeted competencies:

Kenntnis und Verständnis der aufgabenspezifischen physikalischen Grundlagen, Erkennen des Bezugs zu den angrenzenden Gebieten und die Fähigkeit, diese Kenntnisse schriftlich und mündlich darzustellen und für eigene Forschung zu nutzen.

Calculation of student workload:

242 h Preparation / follow-up work

28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Frank Jahnke

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Theoretical Physics - Professional Specialization

Type of examination: module exam

Form of examination:

Presentation, oral

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Theoretical Physics - Professional Specialization

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Laboratory class

Associated module examination:

Module 01-PHY-MA-TP-Adv: Theoretical Physics – Advanced Studies

Theoretical Physics – Advanced Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Theoretical Physics

Content-related prior knowledge or skills:

Electrodynamics, Quantum Mechanics

Learning content:

Introduction to Feynman Diagrams and Quantum Field Theory with Applications to Solid State Physics

or

Theoretical Neurophysics:

With its versatile concepts and formal tools, theoretical physics provides the key to a quantitative description of neuronal dynamics and for understanding computation in the brain:

- Fundamental topics: ion channels/neuroelectronics, rate- and spike-based neuron models and networks, synaptic dynamics/transmission, collective dynamics (synchronization, oscillations, avalanches), learning and memory
- Analytical & computational methods: stability analysis, phase transitions, mean-field dynamics, Fokker-Planck formalism, optimization techniques & machine learning, reinforcement and inference schemes

or

Physics of Complex Systems:

The physics of complex systems uses methods from theoretical physics to study phenomena of complex systems in a broad variety of fields, ranging from biology and social systems, to economics and technological systems as the internet, to the origin of life and astrobiology. This lecture will provide an introduction to the physics of complex systems, covering tools and theories such as complex network theory, complex dynamical systems, self-organized criticality, adaptive networks, and evolutionary dynamics.

Learning outcomes / competencies / targeted competencies:

Understanding the theoretical principles of the above-given learning content, analytical calculation methods, approximation methods and numerical solution techniques, application of theoretical methods to experimental situations.

Calculation of student workload:

70 h Preparation / follow-up work

56 h SWS / presence time / working hours

54 h Exam preparation

Are there optional courses in the modules?

yes

- Introduction to Feynman Diagrams and Quantum Field Theory with Applications to Solid State Physics 6 CP
- Theoretical Neurophysics 6 CP
- Physics of Complex Systems 6 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Frank Jahnke

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid**until:**

WiSe 25/26 / -

Credit points / Workload:

6 / 180 hours

Module examinations**Module examination:** Prüfungsleistung Theoretical Physics – Advanced Studies**Type of examination:** module exam**Form of examination:**

Oral examination (single)

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

1 / - / -

Language(s) of instruction:

English

Module courses**Course:** Theoretical Physics – Advanced Studies**Frequency:**

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

4,00

Teaching format(s):

Lecture

Associated module examination:

Prüfungsleistung Theoretical Physics – Advanced Studies

Module 01-PHY-MA-TP-PrePro: Theoretical Physics - Preparatory Project

Theoretical Physics - Preparatory Project

Assignment to areas of study:

- Focus Areas / Specialization / Theoretical Physics

Content-related prior knowledge or skills:

Master Physics, completion of the 3 specializations

Learning content:

The skills of experimental or theoretical-mathematical practice are acquired in the preparatory project, which are the prerequisite for carrying out the research project within the framework of the Master's thesis. This preparatory project is usually written in one of the specialisations offered in Faculty 1. The work is carried out usually in the laboratories of the research institutes of Faculty 1 under individual guidance (project internship). At the end, a concept paper on a possible research project is written. This paper should usually correspond to the research programme for the upcoming research project of the Master's thesis.

Learning outcomes / competencies / targeted competencies:

- Transferring a scientific question into an experimental and/or theoretical investigation,
- successful strategies in planning and conducting scientific investigations,
- Ability to critically evaluate, classify and discuss own scientific results,
- summarise and present results in a report

Calculation of student workload:

360 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. rer. nat. Frank Jahnke

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

12 / 360 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Theoretical Physics - Preparatory Project

Type of examination: module exam

Form of examination:

Project report

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Theoretical Physics - Preparatory Project

Frequency:
each semester

Language(s) of instruction:
English

Contact hours:
-

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-TP-Add: Theoretical Physics – Additional Studies

Theoretical Physics – Additional Studies

Assignment to areas of study:

- Focus Areas / Fundamentals / Theoretical Physics

Content-related prior knowledge or skills:

Electrodynamics, Quantum Mechanics

Learning content:

In addition to the content of the TP-Intro and TP-Adv modules, supplementary and in-depth topics from the field of theoretical physics in the form of a lecture, seminar or exercise.

Learning outcomes / competencies / targeted competencies:

Concepts and knowledge of modern applications from various areas of theoretical physics.

Calculation of student workload:

28 h SWS / presence time / working hours

34 h Preparation / follow-up work

28 h Exam preparation

Are there optional courses in the modules?

yes

- Theoretical Solid State Physics – Exercises 3 CP
- Relativistic and Many-Body Quantum Mechanics - Exercises 3 CP
- Theoretical Neurophysics - Exercises 3 CP
- Physics of Complex Systems - Exercises 3 CP
- Group Theory - 3 CP

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Michael Andreas Sentef

Frequency:

each semester

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Theoretical Physics – Additional Studies

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Theoretical Physics – Additional Studies

Frequency:

each semester

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Lecture

Tutorial

Seminar

Associated module examination:

Studienleistung Theoretical Physics – Additional Studies

Module 01-PHY-MA-SIP1: Symbiotic Interdisciplinary Projects 1

Symbiotic Interdisciplinary Projects 1

Assignment to areas of study:

- General Studies

Content-related prior knowledge or skills:

Bachelor

Learning content:

- Becoming acquainted with special and up-to-date research fields in physics and other disciplines.
- Obtainment of knowledge of modern research concepts and structures.
- Learning of communicative debate about research contents and concepts with the presenting experts in the fields.

Learning outcomes / competencies / targeted competencies:

Becoming familiar with current topics of experimental or theoretical physics and other disciplines on the basis of expert presentations. Short description of the learnt experience.

Calculation of student workload:

28 h SWS / presence time / working hours

26 h Preparation / follow-up work

36 h Exam preparation

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Annette Ladstätter-Weißmayer

Frequency:

winter semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Symbiotic Interdisciplinary Projects 1

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Symbiotic Interdisciplinary Projects 1

Frequency:

winter semester, yearly

Contact hours:

2,00

Teaching format(s):

Seminar

Language(s) of instruction:

English

Associated module examination:

Module 01-PHY-MA-SIP2: Symbiotic Interdisciplinary Projects 2

Symbiotic Interdisciplinary Projects 2

Assignment to areas of study:

- General Studies

Content-related prior knowledge or skills:

Bachelor

Learning content:

- Intensive acquisition with interdisciplinary research concepts between physics and other disciplines.
- Learn to elaborate of a precise research project sketch.
- Learn to design a dialogue between experts from different disciplines.
- Acquisition of a presentation of a research concept.

Learning outcomes / competencies / targeted competencies:

- Development of creative ideas for interdisciplinary research projects.
- For this, elaboration of detailed research concepts.

Calculation of student workload:

36 h Exam preparation

26 h Preparation / follow-up work

28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Annette Ladstätter-Weißenmayer

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Studienleistung Symbiotic Interdisciplinary Projects 2

Type of examination: module exam

Form of examination:

Announcement at the beginning of the semester

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / 1 / -

Language(s) of instruction:

English

Module courses

Course: Symbiotic Interdisciplinary Projects 2

Frequency:

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

2,00

Teaching format(s):

Seminar

Associated module examination:

Module 01-PHY-MA-MThsPhy: Master Thesis including Colloquium

Master Thesis including Colloquium

Assignment to areas of study:

- Master Thesis

Content-related prior knowledge or skills:

Successful completion of the compulsory, compulsory elective and elective modules.

Learning content:

Based on the chosen focus, a master's thesis is prepared.

Learning outcomes / competencies / targeted competencies:

- Realization of a scientific question into an experimental and/or theoretical investigation
- Application of successful strategies in planning and conducting scientific investigations
- Discussion of a scientific question into an experimental and/or theoretical investigation
- Ability to critically evaluate, classify and discuss one's own scientific results
- Ability to critically evaluate, classify and discuss one's own scientific results
- Ability to summarise and present scientific results in a master thesis

Calculation of student workload:

90 h Exam preparation

810 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:

English

Responsible for the module:

Prof. Dr. Andreas Rosenauer

Frequency:

summer semester, yearly

Duration:

1 semester[s]

The module is valid since / The module is valid until:

WiSe 25/26 / -

Credit points / Workload:

30 / 900 hours

Module examinations

Module examination: Colloquium

Type of examination: module exam

Form of examination:

Colloquium

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

- / - / -

Language(s) of instruction:

German



Module examination: Master Thesis

Type of examination: module exam

Form of examination:

Master Thesis

The examination is ungraded?

no

Number of graded components / ungraded components / prerequisites of the examination:

172 / - / -

Language(s) of instruction:

English

Description:

A colloquium is held for the Master's thesis. A joint module grade is calculated for the Master's thesis and colloquium. The Master's thesis accounts for 2/3 and the colloquium for 1/3 of the joint grade.

Module courses

Course: Master Thesis

Frequency:

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

0,00

Teaching format(s):

Associated module examination:

••••••••

Course: Colloquium

Frequency:

summer semester, yearly

Language(s) of instruction:

English

Contact hours:

0,00

Teaching format(s):

Associated module examination:

Module 01-PHY-MA-0: Ergänzende Veranstaltungen im Master Physik

Ergänzende Veranstaltungen im Master Physik

Assignment to areas of study:

- Additional Courses

Content-related prior knowledge or skills:

none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:

Are there optional courses in the modules?

yes

Language(s) of instruction:

German

Responsible for the module:

N.N.

Frequency:

Duration:

The module is valid since / The module is valid until:

SoSe 23 / -

Credit points / Workload:

Module examinations

Module examination: Ohne Prüfung

Type of examination:

Form of examination:

See description

The examination is ungraded?

yes

Number of graded components / ungraded components / prerequisites of the examination:

- / - / -

Language(s) of instruction:

German

Module courses

Course: Ergänzende Veranstaltungen im Master Physik

Frequency:

Language(s) of instruction:

German

Contact hours:

0,00

Teaching format(s):

Lecture

Tutorial

Seminar

Self-study unit

Associated module examination: