Universität Bremen

Faculty 03: Mathematics/Computer Sciences

Wintersemester 24/25

Module Guide

for the study of

Industrial Mathematics & Data Analysis Master

Master of Science

valid in connection with the examination regulations MPO 2022

According to the Subject-Specific Examination Regulation for the **Area of Focus Data Analysis** of the Master's Program Industrial Mathematics and Data Analysis (Single Major Subject) dated February 9, 2022.

Generated: October 12, 2024

University of Bremen

Curriculum - Master Industrial Mathematics and Data Analysis*

(Focus on Data Analysis)

<table>
<tr><th>Sem.</th><th colspan="2">Foundations
33 CP</th><th colspan="2">Area of Focus
67 CP</th><th colspan="2">Extension
18 CP</th><th>Application Subject
12 CP</th></tr>
<tr><td>1</td><td>Numerical Methods for Partial Differential Equations

9 CP</td><td>Mathematical Methods for Data Analysis and Image Processing

9 CP</td><td>Special Topics Data Analysis A

9 CP</td><td rowspan="3">Advanced Communications Data Analysis

9 CP
(2 x 4,5 CP)

or

Special Topics Data Analysis C

9 CP</td><td colspan="2"></td><td rowspan="3">Modules from one Application Subject

12 CP</td></tr>
<tr><td>2</td><td colspan="2" rowspan="2">Modeling Project

15 CP
(6 CP + 9 CP)</td><td>Special Topics Data Analysis B

9 CP</td><td>Special Topics Industrial Matheamtics A

9 CP</td><td rowspan="2">Advanced Communica-tions Industrial Mathematics

9 CP
(2 x 4,5 CP)</td></tr>
<tr><td>3</td><td></td><td></td></tr>
<tr><td>4</td><td colspan="2"></td><td colspan="2">Master Thesis

30 CP</td><td colspan="2"></td><td></td></tr>
</table>

Credit Points (short CP) indicate the average workload for a course or module, where 1 CP = 30 hours

* According to the Examination Regulation with focus on Data Analysis dated February 9, 2022 including any amendments and corrections

Index by areas of study

bb) Information and Communication (12 CP)

cc) Renewable Energies (12 CP)

dd) Sensors and Electronics (12 CP)

ee) Smart Electronic Systems (12 CP)

b) Geosciences (12 CP)

In total two modules can be selected.

c) Computer Science (12 CP)

Beside the compulsory module "Practical Computer Science" (6 CP), one other module of the following ones can be selected.

d) Physics (12 CP)

Modules from **one** of the following three areas must be selected.

aa) Advanced Physics (12 CP)

bb) Environmental Physics (12 CP)

cc) Spaces Sciences and Technologies (12 CP)

e) Production Engineering (12 CP)

Modules from **one** of the following seven areas must be selected. This application subject can only be completed in German, **not in English**.

aa) Aeronautical Engineering (12 CP)

bb) Energy Systems (12 CP)

cc) General Mechanical Engineering (12 CP)

dd) Industrial Management (12 CP)

ee) Manufacturing Engineering (12 CP)

ff) Materials Sciences (12 CP)

gg) Process Engineering (12 CP)

Module 03-MAT-MA-MDAIP: Mathematical Methods for Data Analysis and Image Processing

Mathematical Methods for Data Analysis and Image Processing

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Foundations	Knowledge from Analysis 1-2, Analysis 3, Linear Algebra 1-2 and Numerical Mathematics 1, along with experience in the use of a Mathematical Software.

Learning content:

Basic methods (histogram analysis, filter methods, digital transforms), Fourier transform (continuous and discrete), morphological methods and their analytical models, PDE-based image processing (Perona-Malik, non-isotropic diffusion).

Information theory (Shannon, Nyquist), image compression, clustering, and classification algorithms.

Image reconstruction (denoising, deconvolution, Radon transform, inpainting), regularization, and the direct method of variational calculus.

Applications in hyperspectral data analysis and in tomography.

Learning outcomes / competencies / targeted competencies:

The ability to obtain appropriate mathematical models for applied problems in data analysis and image processing.

A deep and secure understanding of the mathematical foundations of data analysis and image processing.

Experience with the use of algorithms to solve basic tasks in data analysis and image processing along with a deeper knowledge of and the successful practice of implementation in at least one field of application, e.g. medical imaging reconstruction.

Calculation of student workload:

84 h SWS / presence time / working hours
32 h Exam preparation
154 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Peter Maaß
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: Combination Examination

Type of examination: combination 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 / 1 / -	
Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)	
Description: Type of Examination: Oral or Written Exam. The Coursework requirements will be decided upon by the Lecturer at the beginning of the course (Weekly Worksheets, Midterm Exam, etc.).	

Module courses

Course: Lecture with Exercise	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 6,00	**University teacher:** Prof. Dr. Peter Maaß
Teaching method(s):	**Associated module examination:** Examination(s) on Mathematical Methods for Data Analysis and Image Processing
Associated module courses **Mathematical Methods for Data Analysis and Image Processing** (Lecture)	

Module 03-MAT-MA-NPDE: Numerical Methods for Partial Differential Equations
NPDE: Numerical Methods for Partial Differential Equations

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Foundations	Knowledge from Numerical Mathematics 1 & 2 and Functional Analysis, along with experience in programming.

Learning content:
Examples and types of partial differential equations, classical and weak solutions, numerical methods including finite difference and finite element methods for elliptic and parabolic problems. Numerical analysis for linear problems. Implementation aspects and programming practices. Additional topics depend on the lecturer, for example: adaptive methods, nonlinear problems, finite volume methods.

Learning outcomes / competencies / targeted competencies:
Knowledge of numerical methods for partial differential equations and the ability to apply them. Competency in the numerical analysis of a variety of methods; their stability, approximation properties, and convergence. Practical experience with efficient implementations of suitable algorithms. The ability to select and apply appropriate and efficient methods for given application problems.

Calculation of student workload:
84 h SWS / presence time / working hours
32 h Exam preparation
154 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Alfred Schmidt
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: Combination Examination

Type of examination: combination exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)

Description:
Type of Examination: Oral or Written Exam.

The Coursework requirements will be decided upon by the Lecturer at the beginning of the course (Weekly Worksheets, Midterm Exam, etc.).

Module courses

Course: Lecture and Exercise on Numerical Methods for Partial Differential Equations	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 6,00	**University teacher:** Prof. Dr. Alfred Schmidt
Teaching method(s):	**Associated module examination:** Examination(s) on Numerical Methods for Partial Differential Equations
Associated module courses **Numerical Methods for Partial Differential Equations** (Lecture)	

Module 03-MAT-MA-MP: Modeling Project
Modeling Project

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Foundations	Knowledge from Mathematical Methods for Data Analysis and Image Processing and Numerical Methods for Partial Differential Equations, along with experience in programming.

Learning content:

Working in pairs on a specific task from an industrial, engineering or scientific context:

- Formulation of the problem, definition of the mathematical aspects of the task.
- Implementation of the problem in mathematical models.
- Analysis of the models, selection or development of numerical methods for their evaluation and simulation, iterative improvement of the models.
- Calculation of concrete solutions through the use of given or self-developed software, procurement and processing of relevant data.
- Run multiple sensitivity analyses of the data and parameter studies.
- Interpretation of the results in the language of technology or natural sciences.
- Presentation and communication of the results.

Learning outcomes / competencies / targeted competencies:

The ability to solve practical, real-world tasks without a predetermined solution through, in particular:

- The development of complex mathematical models and suitable simulation tools.
- The acquisition of additional, not necessary mathematical specialist knowledge as well as the procurement of necessary information and data.

The knowledge of and ability to use project development and management mechanisms, among others:

- Cooperation with student partner and with the fictional "client".
- Communication within the subject boundaries and beyond.
- Presentation of results in a variety of media.

Calculation of student workload:

56 h SWS / presence time / working hours
320 h Preparation / follow-up work
74 h Exam preparation

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Dr. Matthias Knauer
Frequency:	**Duration:**
summer semester, yearly	2 semester[s]

The module is valid since / The module is valid until: WiSe 23/24 / -	**Credit points / Workload:** 15 / 450 hours

Module examinations

Module examination: Combination Examination	
Type of examination: combination exam	
Form of examination: Portfolio (AT § 8 Abs. 8)	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 3 / - / -	
Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)	
Description: The following tasks must be completed and make up the displayed percentage of the final grade: • Presentation/Talk (30%) • Report (50%) • Poster Presentation (20%)	

Module courses

Course: Courses and Projects	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Project	**Associated module examination:** Examination(s) on the Modeling Project
Associated module courses **Modeling Project (Part 2)** (Seminar)	

Module 03-MAT-MA-STDA-A: Special Topics Data Analysis A
Special Topics Data Analysis A

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Area of Focus - Data Analysis / Compulsory Modules	Knowledge from applicable Master of Industrial Mathematics and Data Analysis courses, particularly Mathematical Methods for Data Analysis and Image Processing.

Learning content:
The content depends on the student's choice of course. A range of Data Analysis topics are available, for example, machine learning, inverse problems, image processing and statistics.

Learning outcomes / competencies / targeted competencies:
Students are able to develop advanced mathematical methods, to analyze them mathematically, and to implement efficient algorithms based on these methods. They know basic as well as advanced concepts from data analysis and can adapt them to solve special problems, in particular from an industrial and engineering context.

Calculation of student workload:
84 h SWS / presence time / working hours
32 h Exam preparation
154 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Students are given the choice of a wide-variety of subjects offered in this module each semester. A list of the offered courses can be found in the Course Catalogs, which will be released prior to the start of each semester.

Language(s) of instruction:	**Responsible for the module:**
English	Dr. Ingolf Schäfer
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: Combination Examination	
Type of examination: combination exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)
Description: Type of Examination: Oral or Written Exam. The Coursework requirements will be decided upon by the Lecturer at the beginning of the course (Weekly Worksheets, Midterm Exam, etc.).

Module courses

Course: Lecture and Exercise from the Area of Data Analysis	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 6,00	**University teacher:** Lecturers from Mathematics
Teaching method(s):	**Associated module examination:** Examination(s) on the selected course

Associated module courses

Advanced Topics in Image Processing - The Beauty of Variational Calculus (Lecture)

Algebraic Topology (Lecture)

Algorithms and Uncertainty ()

Basics of Mathematical Statistics (Statistics I) (Lecture)

Convex Analysis and Optimization (Lecture)

Finite Elements - Selected Chapters (Lecture)

Mathematical Concepts of Risk Management (Statistics III) (Lecture)

Module 03-MAT-MA-STDA-B: Special Topics Data Analysis B
Special Topics Data Analysis B

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Area of Focus - Data Analysis / Compulsory Modules	Knowledge from applicable Master of Industrial Mathematics and Data Analysis courses, particularly Mathematical Methods for Data Analysis and Image Processing.

Learning content:
The content depends on the student's choice of course. A range of Data Analysis topics are available, for example, machine learning, inverse problems, image processing and statistics.

Learning outcomes / competencies / targeted competencies:
Students are able to develop advanced mathematical methods, to analyze them mathematically, and to implement efficient algorithms based on these methods. They know basic as well as advanced concepts from data analysis and can adapt them to solve special problems, in particular from an industrial and engineering context.

Calculation of student workload:
84 h SWS / presence time / working hours
154 h Preparation / follow-up work
32 h Exam preparation

Are there optional courses in the modules?
yes
Students are given the choice of a wide-variety of subjects offered in this module each semester. A list of the offered courses can be found in the Course Catalogs, which will be released prior to the start of each semester.

Language(s) of instruction:	**Responsible for the module:**
English	Dr. Ingolf Schäfer
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: Combination Examination	
Type of examination: combination exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)

Description:
Type of Examination: Oral or Written Exam.

The Coursework requirements will be decided upon by the Lecturer at the beginning of the course (Weekly Worksheets, Midterm Exam, etc.).

Module courses

Course: Lecture and Exercise from the Area of Data Analysis

Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 6,00	**University teacher:** Lecturers from Mathematics
Teaching method(s):	**Associated module examination:** Examination(s) on the selected course

Associated module courses

Advanced Topics in Image Processing - The Beauty of Variational Calculus (Lecture)

Algebraic Topology (Lecture)

Algorithms and Uncertainty ()

Basics of Mathematical Statistics (Statistics I) (Lecture)

Convex Analysis and Optimization (Lecture)

Finite Elements - Selected Chapters (Lecture)

Mathematical Concepts of Risk Management (Statistics III) (Lecture)

Module 03-MAT-MA-MTIM: Module Master Thesis
Module Master Thesis

Assignment to areas of study:	Content-related prior knowledge or skills:
• Area of Focus - Data Analysis / Compulsory Modules	The topic must belong to the student's chosen field of specialization (Data Analysis or Industrial Mathematics) and a minimum of 81CP is required for registration.

Learning content:
The Master Thesis Module involves the in-depth examination of a topic from Data Analysis/Industrial Mathematics. It comprises of a Master's thesis and a colloquium as the result of an extensive exploration of a subject up to the boundary of current scientific research. The concrete topic - and its scope of application - typically builds upon a previously completed modeling project or specialized course.

Learning outcomes / competencies / targeted competencies:
The ability to understand and independently work on scientific premises, in particular:

- The independent handling of a problem relevant to certain applications in the natural sciences or engineering that employ mathematical methods - especially mathematical modeling as well as numerical evaluation and simulation,
- Working within a given time frame,
- Finding and utilizing scientific publications (monographs, journal articles, preprints),
- Generating own research results as far as possible,
- Gaining insights into current research,
- Writing a substantial mathematical text that adheres to the rules of good scientific practice,
- Including a reasonable structuring and containment of the topic,
- Presenting work in the form of a conference talk, which is reasonably structured and contains a concise overview of the topic.

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Dr. Ingolf Schäfer
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	30 / 900 hours

Module examinations

Module examination: Master Thesis

Type of examination: combination exam

Form of examination: Master Thesis	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)	

Module examination: Colloquium	
Type of examination: combination exam	
Form of examination: Colloquium	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)	

Module courses

Course: Master Thesis and Colloquium	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 0,00	**University teacher:**
Teaching method(s):	**Associated module examination:** Master Thesis Colloquium

Module 03-MAT-MA-ACDA: Advanced Communications Data Analysis
Advanced Communications Data Analysis

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Area of Focus - Data Analysis / Compulsory Elective Modules	Knowledge from applicable Master of Industrial Mathematics and Data Analysis courses.

Learning content:
The content will depend on the student's choice from a variety of courses that build upon topics addressed in a previous Master's lecture. A range of Data Analysis topics are available, including machine learning, inverse problems, image processing and statistics.

Learning outcomes / competencies / targeted competencies:
Extended experience in independent scientific work through:

- Acquiring and compiling information on an advanced Data Analysis topic.
- Performing additional literature research.
- Preparing and giving a talk that utilizes appropriate presentation techniques and tools.
- Participating in discussions on a scientific topic.
- Writing a mathematical text according to universal and citing standards.

Calculation of student workload:
150 h Preparation / follow-up work
64 h Exam preparation
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	Dr. Ingolf Schäfer
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: Examination for the selected Course

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner)

Module examination: Examination for the selected Course	
Type of examination: partial 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: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner)	

Module courses

Course: 1. Seminar on Advanced Topics from Data Analysis	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:** Lehrende der Mathematik
Teaching method(s): Seminar	**Associated module examination:** Examination on the selected Course
Associated module courses **Challenges in Inverse Problems** (Seminar) **High-Performance-Visualisierung** (Seminar) **Introduction to Robust Control** (Seminar) **Mathematical Methods in Machine Learning** (Seminar) **Recent Trends in Algorithm Theory** ()	

Course: 2. Seminar on Advanced Topics from Data Analysis	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:** Lehrende der Mathematik
Teaching method(s): Seminar	**Associated module examination:** Examination on the selected Course
Associated module courses **Challenges in Inverse Problems** (Seminar) **High-Performance-Visualisierung** (Seminar) **Introduction to Robust Control** (Seminar)	

Mathematical Methods in Machine Learning (Seminar)

Recent Trends in Algorithm Theory ()

Module 03-MAT-MA-STDA-C: Special Topics Data Analysis C
Special Topics Data Analysis C

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Area of Focus - Data Analysis / Compulsory Elective Modules	Knowledge from applicable Master of Industrial Mathematics and Data Analysis courses, particularly Mathematical Methods for Data Analysis and Image Processing.

Learning content:
The content depends on the student's choice of course. A range of Data Analysis topics are available, for example, machine learning, inverse problems, image processing and statistics.

Learning outcomes / competencies / targeted competencies:
Students are able to develop advanced mathematical methods, to analyze them mathematically, and to implement efficient algorithms based on these methods. They know basic as well as advanced concepts from data analysis and can adapt them to solve special problems, in particular from an industrial and engineering context.

Calculation of student workload:
154 h Preparation / follow-up work
84 h SWS / presence time / working hours
32 h Exam preparation

Are there optional courses in the modules?
yes
Students are given the choice of a wide-variety of subjects offered in this module each semester. A list of the offered courses can be found in the Course Catalogs, which will be released prior to the start of each semester.

Language(s) of instruction:	**Responsible for the module:**
English	Dr. Ingolf Schäfer
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: Combination Examination	
Type of examination: combination exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)
Description: Type of Examination: Oral or Written Exam. The Coursework requirements will be decided upon by the Lecturer at the beginning of the course (Weekly Worksheets, Midterm Exam, etc.).

Module courses

Course: Lecture and Exercise from the Area of Data Analysis	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 6,00	**University teacher:** Lecturers from Mathematics
Teaching method(s):	**Associated module examination:** Examination(s) on the selected course

Associated module courses

Advanced Topics in Image Processing - The Beauty of Variational Calculus (Lecture)

Algebraic Topology (Lecture)

Algorithms and Uncertainty ()

Basics of Mathematical Statistics (Statistics I) (Lecture)

Convex Analysis and Optimization (Lecture)

Finite Elements - Selected Chapters (Lecture)

Mathematical Concepts of Risk Management (Statistics III) (Lecture)

Module 03-MAT-MA-ACIM: Advanced Communications Industrial Mathematics
Advanced Communications Industrial Mathematics

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Extension - Industrial Mathematics	Knowledge from applicable Master of Industrial Mathematics and Data Analysis courses.

Learning content:
The content will depend on the student's choice from a variety of courses that build upon topics addressed in a previous Master's lecture. A range of Industrial Mathematics topics are available, including finite element methods, optimal control, nonlinear optimization, inverse problems.

Learning outcomes / competencies / targeted competencies:
Extended experience in independent scientific work through:

- Acquiring and compiling information on an advanced Industrial Mathematics topic.
- Performing additional literature research.
- Preparing and giving a talk that utilizes appropriate presentation techniques and tools.
- Participating in discussions on a scientific topic.
- Writing a mathematical text according to universal and citing standards.

Calculation of student workload:
56 h Exam preparation
150 h SWS / presence time / working hours
64 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	Dr. Ingolf Schäfer
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: 1. Examination

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner)

Module examination: 2. Examination	
Type of examination: partial 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: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner)	

Module courses

Course: 1. Seminar on Advanced Topics from Industrial Mathematics	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:** Lecturers from Mathematics
Teaching method(s): Seminar	**Associated module examination:** Examination on selected Course
Associated module courses **Advanced Numerical Methods for Partial Differential Equations** (Seminar) **Challenges in Inverse Problems** (Seminar) **High-Performance-Visualisierung** (Seminar) **Introduction to Robust Control** (Seminar) **Mathematical Methods in Machine Learning** (Seminar) **Recent Trends in Algorithm Theory** ()	

Course: 2. Seminar on Advanced Topics from Industrial Mathematics	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:** Lecturers from Mathematics
Teaching method(s): Seminar	**Associated module examination:** Examination on selected Course
Associated module courses **Advanced Numerical Methods for Partial Differential Equations** (Seminar) **Challenges in Inverse Problems** (Seminar)	

High-Performance-Visualisierung (Seminar)

Introduction to Robust Control (Seminar)

Mathematical Methods in Machine Learning (Seminar)

Recent Trends in Algorithm Theory ()

Module 03-MAT-MA-STIM-A: Special Topics Industrial Mathematics A

Special Topics Industrial Mathematics A

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Extension - Industrial Mathematics	Knowledge from applicable Master of Industrial Mathematics and Data Analysis courses, particularly Numerical Methods for Partial Differential Equations.

Learning content:
The content depends on the student's choice of course. A range of Industrial Mathematics topics are available, for example, finite element methods, optimal control, nonlinear optimization and inverse problems.

Learning outcomes / competencies / targeted competencies:
Students are able to develop advanced mathematical methods, to analyze them mathematically, and to implement efficient algorithms based on these methods. They know basic as well as advanced concepts from industrial mathematics and can adapt them to solve special problems, in particular from an industrial and engineering context.

Calculation of student workload:
32 h Exam preparation
84 h SWS / presence time / working hours
154 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Students are given the choice of a wide-variety of subjects offered in this module each semester. A list of the offered courses can be found in the Course Catalogs, which will be released prior to the start of each semester.

Language(s) of instruction:	**Responsible for the module:**
English	Dr. Ingolf Schäfer
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	9 / 270 hours

Module examinations

Module examination: Combination Examination	
Type of examination: combination exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction: Englisch / German (Examinations are usually conducted in English, but can also be taken in another language after consultation with the examiner.)
Description: Type of Examination: Oral or Written Exam. The Coursework requirements will be decided upon by the Lecturer at the beginning of the course (Weekly Worksheets, Midterm Exam, etc.).

Module courses

Course: Lecture and Exercise from the Area of Industrial Mathematics	
Frequency: each semester	**Language(s) of instruction:** Englisch
Contact hours: 6,00	**University teacher:** Lecturers from Mathematics
Teaching method(s):	**Associated module examination:** Examination(s) on the selected course

Associated module courses

Advanced Topics in Image Processing - The Beauty of Variational Calculus (Lecture)

Algebraic Topology (Lecture)

Algorithms and Uncertainty ()

Basics of Mathematical Statistics (Statistics I) (Lecture)

Convex Analysis and Optimization (Lecture)

Finite Elements - Selected Chapters (Lecture)

Module 01-ET-BA-GEAT: Grundlagen der Energie- und Automatisierungstechnik
Introduction to Energy and Automation Engineering

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Automation Technology • Technical Application Subject / Electrical Engineering / Renewable Energies	Mathematische, physikalische und elektrotechnische Grundlagen aus den ersten 4 Semestern der ingenieurwissenschaftlichen Studiengänge

Learning content:

Das Modul besteht aus den drei Teilbereichen

- Grundlagen der Regelungstechnik
- Grundlagen der Elektrischen Energietechnik
- Grundlagen der Automatisierungstechnik

Lernhinhalte Grundlagen der Regelungstechnik:

- Grundsätzliche Einführung in die Regelungstechnik (Analyse, Modellbildung, Reglerentwurf)
- Modellbildung, einfache Übertragungsglieder
- Übertragungsfunktion
- Frequenzgangdarstellung, Bode-Diagramme
- Stabilität linearer Systeme
- PID-Regler, Strukturerweiterungen

Lernhinhalte Grundlagen der Elektrischen Energietechnik:

- Entwicklung der Elektroenergiesysteme
- Verbundnetze Lastprofile
- Erzeugung elektrischer Energie, CO2-Problematik
- Generatoren
- Elektrische Netze und Transport
- Leitungen
- Transformatoren
- Energiebedarf
- Aktuelle und zukünftige Entwicklung
- Verbundbetrieb
- Netzplanung
- Lastflussrechnung
- Netzanschlussregeln + EN50160
- Kurzschlussberechnung

Lernhinhalte Einführung in die Automatisierungstechnik:

- Anwendungsorientierte Einführung in die Automatisierungstechnik
- Aufgaben, Aufbau und Bestandteile eines Automatisierungssystems
- Begriffe und Normen
- Struktur und Arbeitsweise speicherprogrammierbarer Steuerungen und Kommunikationslösungen
- Praxisorientierte Anwendungsbeispiele von Automatisierungslösungen

Literatur zum Modul:

- Zu den Grundlagen der Regelungstechnik wird vor Vorlesungsbeginn ein Manuskript in Buchform bereitgestellt.
- Literatur zu den Grundlagen der Energietechnik sowie Einführung in die Automatisierungstechnik wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcomes / competencies / targeted competencies:
Nach Abschluss der Vorlesung sollen die Studenten und Studentinnen

- ein regelungstechnisches Problem grundsätzlich als solches erkennen und beschreiben können,
- das Prinzip der Stabilität eines Regelkreises verinnerlicht haben,
- sämtliche Schritte ausführen können, die zum Entwurf eines einfachen Reglers erforderlich sind (Systemanalyse, formale Modellbildung, Auswahl eines geeigneten Reglers, Stabilitätsprüfung),
- die nötigen Grundlagen für alle weitergehenden regelungstechnischen Vorlesungen besitzen,
- grundlegende Eigenschaften der Bau- und Betriebsweise von Elektroenergiesystemen kennen,
- eine umfassende Übersicht der Betriebsmittel für Elektroenergiesysteme besitzen,
- die Zusammenhänge von Quellen und Netzen erkennen, vereinfachen und berechnen können,
- einfache Netz- und Betriebsmittelberechnungen in elektr. Energiesystemen ausführen können,
- Automatisierungssysteme unter technischen Gesichtspunkten einordnen und beschreiben können,
- Ansätze für geeignete Automatisierungslösungen einschlägiger Anwendungen ableiten können.

Calculation of student workload:
102 h Exam preparation
70 h Preparation / follow-up work
98 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr.-Ing. Johanna Myrzik
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 20/21 / -	9 / 270 hours

Module examinations

Module examination: Grundlagen der elektrischen Energietechnik

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Grundlagen der Regelungstechnik

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Deutsch

Module examination: Einführung in die Automatisierungstechnik	
Type of examination: partial exam	
Form of examination: Oral	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Deutsch	

Module courses

Course: Grundlagen der elektrischen Energietechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 3,00	**University teacher:** Prof. Dr.-Ing. Johanna Myrzik
Teaching method(s):	**Associated module examination:** Grundlagen der elektrischen Energietechnik
Associated module courses **Grundlagen der Elektrischen Energietechnik** (Lecture)	

Course: Grundlagen der Regelungstechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 3,00	**University teacher:** Prof. Dr.-Ing. Kai Michels
Teaching method(s):	**Associated module examination:** Grundlagen der Regelungstechnik
Associated module courses **Grundlagen der Regelungstechnik** (Lecture)	

Course: Einführung in die Automatisierungstechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 1,00	**University teacher:** Dr.-Ing. Holger Groke

Teaching method(s):	**Associated module examination:**
Lecture	Einführung in die Automatisierungstechnik

Associated module courses

Einführung in die Automatisierungstechnik (Lecture)

Module 01-ET-MA-ATP: Automatisierung Technischer Prozesse
Automation Projects

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Automation Technology	none

Learning content:

- Projekte der Automatisierungstechnik
- Einsatz und Planung benötigter Ressourcen und verfügbarer Infrastruktur
- Vorgehensmodelle bei der Entwicklung, Qualitätssiherung, Dokumentation sowie Projekt- und Konfigurationsmanagement
- Prozess-, Produkt- und Zustandsorientierte Konzepte der Modellierung
- Überwachung technischer Prozesse
- Führung technischer Prozesse
- Sytematsiche Projektabwicklung; vom Lasten- und Pflichtenheft zur Projektplanung
- Beispielsystem (von der Entwurfs- zur Umsetzungs- und Inbetriebnahmephase)

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcomes / competencies / targeted competencies:

Nach erfolgreichem Abschluss des Moduls beherrschen die Studierenden:

- grundlegende Verfahren zur Abwicklung von Projekten in der Automatisierungstechnik;
- Methoden und Konzepte zur Modellierung von Prozessen ;
- Verfahren zur Überwachung technischer Prozesse ;
- Verfahren zur gezielten Manipulation technischer Prozesse;
- Methoden des Projektmanagements.

Calculation of student workload:

70 h SWS / presence time / working hours
56 h Preparation / follow-up work
54 h Exam preparation

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
German	Dr.-Ing. Holger Groke
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

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: - / - / -	
Language(s) of instruction: Deutsch	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: Automatisierung Technischer Prozesse	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 5,00	**University teacher:** Dr.-Ing. Holger Groke
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Automatisierung technischer Prozesse** (Lecture)	

Module 01-ET-MA-Antec: Praktikum Antriebstechnik
Laboratory Electrical Drives

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Automation Technology	none

Learning content:
Die Aufgabenstellungen orientieren sich inhaltlich an aktuellen Forschungsgebieten der elektrischen Energie- und Antriebstechnik und stellen so den direkten Praxisbezug her. Die konkreten Aufgabenstellungen werden individuell vereinbart.

Anhand einer vorgegebenen Aufgabenstellung werden den Studierenden die notwendigen wissenschaftlichen Methoden zur Einarbeitung in neue Themengebiete, Lösungsfindung, praktische Umsetzung sowie der entsprechenden Dokumentation vermittelt

Learning outcomes / competencies / targeted competencies:
Im Rahmen des Praktikums lernen die Studierenden am Beispiel ihrer konkreten Aufgabe die Durchführung, Einordnung und Bewertung von Recherchen sowie die Nutzung der erzielten Ergebnisse für die Bearbeitung einer gestellten Aufgabe.

Das Praktikum vermittelt damit die Methodenkompetenzen, die für die erfolgreiche Bearbeitung der Masterarbeit im vorgegebenen Zeitrahmen erforderlich sind.

Calculation of student workload:
30 h Self-study
32 h Preparation / follow-up work
2 h Tutorial
28 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr.-Ing. Amir Ebrahimi
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Portfolio (AT § 8 Abs. 8)	**The examination is ungraded?** no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Deutsch
Description: Anzahl Studienleistungen: 1 (Versuchsdurchführung und Versuchsprotokolle)

Module courses

Course: Praktikum Antriebstechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Amir Ebrahimi
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung

Module 01-ET-MA-EAT(a): Elektrische Antriebstechnik
Electrical Drives

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Automation Technology	Grundkenntnisse der elektrischen Maschinen; Grundlagen der Regelungstechnik

Learning content:

- Zusammenfassung einiger mechanischer Grundlagen
- Erwärmung elektrischer Maschinen
- Aufbau, dynamisches und stationäres Verhalten von Gleichstrommaschinen
- Regelung von Gleichstrommaschinen
- Aufbau, dynamisches und stationäres Verhalten von Drehfeldmaschinen
- Prinzip der Feldorientierung
- Feldorientierte Regelung von Asynchronmaschinen
- Feldorientierte Regelung von permanent magneterregten Synchronmaschinen

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcomes / competencies / targeted competencies:
Nach erfolgreichem Abschluss des Moduls können die Studierenden:

- das mechanische und thermische Verhalten von elektrischen Maschinen verstehen und anwenden;
- Regelungen für Gleichstrom-, Asynchron- und Synchronmaschinen konzipieren und dimensionieren;
- das Antriebsverhalten in Simulationen auf der Grundlage der abgeleiteten Modelle untersuchen.

Calculation of student workload:
70 h SWS / presence time / working hours
68 h Exam preparation
42 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German / English	Prof. Dr.-Ing. Amir Ebrahimi
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Written examination	**The examination is ungraded?** no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Deutsch
Description: Anzahl der Prüfungsleistungen: 1

Module courses

Course: Elektrische Antriebstechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch / English
Contact hours: 5,00	**University teacher:** Prof. Dr.-Ing. Amir Ebrahimi
Literature: Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.	
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung
Associated module courses **Elektrische Antriebstechnik** (Lecture)	

Module 01-ET-MA-LEA: Leistungselektronik in der Automatisierungstechnik
Power Electronics for Automation Technology

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Automation Technology	none

Learning content:

Im theoretischen Teil 1

- Besonderheiten der Leistungselektronik
- Leistungssteuerung mittels Taktung
- Parasitäre Komponenten
- Beschaltung der Bauelemente für entlastetes und weiches Schalten
- Grundlegende Bauelementkonzepte (PIN- und Schottky-Diode, MOSFET, IGBT)
- Stationäres und dynamisches Verhalten
- Praktische Umsetzungen und Technologievarianten

Im theoretischen Teil 2

- Topologien von Gleichstromstellern
- Ansteuerverfahren, Oberschwingungen, totzeitbedingte Spannungsfehler
- Topologien von Drehstrompulswechselrichtern
- Funktionsweise und Modulationsverfahren

Im praktischen Teil

- Mehrpunktwechselrichter
- Pulswechselrichter

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcomes / competencies / targeted competencies:

Die Studierenden:

- kennen die grundlegenden Umwandlungsprinzipien der Leistungselektronik (LE);
- kennen die verwendeten Schaltungen und Halbleiterbauelemente;
- kennen die Charakteristika dieser Grundschaltungen und Bauelemente und deren Wechselwirkungen;
- kennen die wesentlichen Unterschiede zur Niederspannungstechnik (z.B. Logik, Analogtechnik) und die Rahmenbedingungen für den Einsatz von LE;
- haben eine Vorstellung von den Größenverhältnissen in der LE;
- können einzelne Schaltungen und Komponenten dimensionieren; (Anteil Theorie);
- kennen Aufbau und Funktionsweise von selbstgeführten leistungselektronischen Stromrichtern für den Einsatz in der Antriebstechnik
- beherrschen Steuerverfahren von selbstgeführten Stromrichtern;
- haben Kenntnisse über Oberschwingungen und Netzrückwirkungen durch Stromrichter. (Anteil Praxis)

Calculation of student workload:

56 h Preparation / follow-up work
54 h Exam preparation
70 h SWS / presence time / working hours

Are there optional courses in the modules? no

Language(s) of instruction: German	**Responsible for the module:** Prof. Dr.-Ing. Nando Kaminski
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Written examination	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Deutsch	
Description: Anzahl der Prüfungsleistungen: 1	

Module courses

Course: Leistungselektronik in der Automatisierungstechnik	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 5,00	**University teacher:** Prof. Dr.-Ing. Nando Kaminski
Literature: Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.	
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung

Module 01-ET-MA-LRT: Praktikum Regelungstechnik / Advanced Control Lab
Advanced Control Lab

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Automation Technology • Technical Application Subject / Electrical Engineering / Renewable Energies	Lecture "Control Theory I"

Learning content:

- Crane: Modelling, analysis, and state space control (pole placement method) of a crane
- Inverted pendulum I: Swinging up of an inverted pendulum using different methods
- Inverted pendulum II: Modelling, analysis, and state space control (pole placement method) for the stabilization of an inverted pendulum
- Helicopter: Modelling, analysis, and state space control (Riccati method) of a helicopter model
- Identification and control with an industrial plant control system

References:

- Michels, K.: Script „Control Engineering“ (German and English)
- Scripts for each experiment are available in German and English

Learning outcomes / competencies / targeted competencies:
The students shall get experience with the design and practical application of complex controllers.

Calculation of student workload:
15 h SWS / presence time / working hours
75 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr.-Ing. Kai Michels
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / SoSe 24	3 / 90 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination:	**The examination is ungraded?**
Portfolio (AT § 8 Abs. 8)	no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Englisch / German
Description: Anzahl Studienleistungen: 1

Module courses

Course: Praktikum Regelungstechnik	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Kai Michels
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung
Associated module courses **Praktikum Regelungstechnik / Advanced Control Lab** ()	

Module 01-ET-MA-PAut(a): Process Automation in Power Grids
Process Automation in Power Grids

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Automation Technology	none

Learning content:
- Basics on process automation operation and control principles
- Sensor and actuators
- Power electronic interfaces
- Programming logic controllers
- Process automation in electrical power systems
- Data and field components
- Network operation principles

Learning outcomes / competencies / targeted competencies:
This lecture on process automation is an independent one-semester course which will give you a basic knowledge in the wide field of process automation. After the course you will be able to understand the basic structures, operation and control principles of automation processes. You will understand the working principle of the most used sensors, actuators and programming logic controllers. You will be able to program small control tasks. The second part of the course will focus on the process automation in electrical power supply networks. Beside the required field and data components you will get a broad understanding into the network operation principles and tasks of the grid operators.

Calculation of student workload:
56 h SWS / presence time / working hours
68 h Exam preparation
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr.-Ing. Johanna Myrzik
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination:	**The examination is ungraded?**
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Englisch / German
Description: Anzahl Prüfungsleistungen: 1.

Module courses

Course: Process Automation in Power Grids	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Johanna Myrzik
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Process Automation in Power Grids** (Lecture)	

Module 01-PHY-MA-TANW-PHY-AO: Angewandte Optik
Applied Optics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Advanced Physics	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Dr. Ingolf Schäfer
Frequency:	**Duration:**
The module is valid since / The module is valid until: WiSe 22/23 / -	**Credit points / Workload:** 12 / 360 hours

Module examinations

Module examination: Studienleistung

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module examination: Graded Examination

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module courses

Course: Seminar

Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Seminar	**Associated module examination:**

Course: Vorlesung	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Lecture	**Associated module examination:**

Course: Vorlesung mit Übung	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s):	**Associated module examination:**

Module 04-PT-MA-M11-BM1-LT: Basismodul 1 - LT – Mechanik und Auslegung
Mechanics and Design

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Production Engineering / Aeronautical Engineering	

Learning content:

Learning outcomes / competencies / targeted competencies:

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?
no

Language(s) of instruction:	Responsible for the module:
German	Dipl.-Ing. Christoph Hoffmeister
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Mechanics of Fibre Composite I

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Higher Strength Theory and Structural Mechanics in Lightweight Construction

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Deutsch

Module courses

Course: Mechanik der Faserverbundwerkstoffe I	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Dipl.-Ing. Christoph Hoffmeister David Droste
Literature: • Vorlesungsskript • Gross D., Hauger W., Schnell W., Wriggers P., Technische Mechanik, Band 4, Springer Berlin, 2009 • Niederstadt G., e.a. Ökonomischer und ökologischer Leichtbau mit faserverstärkten Polymeren, Expert-Verlag, 1997 • Konstruieren mit Faser-Kunststoff-Verbunden, Schürmann H., Springer Verlag Berlin Heidelberg, 2007	
Teaching method(s): Lecture	**Associated module examination:** 1. Prüfungsleistung Mechanik der Faserverbundwerkstoffe I
Associated module courses **Mechanik der Faserverbundwerkstoffe I** (Lecture)	

Course: Höhere Festigkeitslehre und Strukturmechanik im Leichtbau	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Dr..Ing. Mostafa Mehrafza
Literature: • Vorlesungsskript • Gross D., Hauger W., Schnell W., Wriggers P., Technische Mechanik, Band 4, Springer Berlin, 2009 • Niederstadt G., e.a. Ökonomischer und ökologischer Leichtbau mit faserverstärkten Polymeren, Expert-Verlag, 1997 • Konstruieren mit Faser-Kunststoff-Verbunden, Schürmann H., Springer Verlag Berlin Heidelberg, 2007	
Teaching method(s): Lecture	**Associated module examination:** 2. Prüfungsleistung Höhere Festigkeitslehre und Strukturmechanik im Leichtbau

Module 01-PHY-MA-TANW-PHY-AP: Astrophysik
Astrophysics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Advanced Physics	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Dr. Ingolf Schäfer
Frequency:	**Duration:**
The module is valid since / The module is valid until: WiSe 22/23 / -	**Credit points / Workload:** 12 / 360 hours

Module examinations

Module examination: Graded Examination

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module examination: Study Achievements / Coursework

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module courses

Course: Vorlesung

Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Lecture	**Associated module examination:**

Course: Vorlesung mit Übung	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s):	**Associated module examination:**

Course: Seminar	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Seminar	**Associated module examination:**

Course: Praktikum	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:**

Module 04-PT-MA-M11-BM2-LT: Basismodul 2 - LT – Raumfahrtsysteme
Systems in Spaceflight

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Production Engineering / Aeronautical Engineering	Grundkenntnisse der Technischen Mechanik

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:
48 h Preparation / follow-up work
84 h SWS / presence time / working hours
48 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Dr.-Ing. Benny Rievers
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Spaceflight Mechanics

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
Deutsch

Module examination: Structues and Systems in Spaceflight

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module courses

Course: Raumflugmechanik	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 3,00	**University teacher:** Dr.-Ing. Benny Rievers
Literature: • Understanding Space, ISBN 0-07-057027-2 • Space Mission Analysis and Design, Larson und Wertz, ISBN 1-881883-01-9 • Human Spaceflight, Larson, ISBN 0-07-236811-X • Visualizing Project Management, K. Forsberg, ISBN 0-471-57779-0 • Kermode, A.C.: Mechanics of Flight. Longman Scientific & Technical, 1987. • Shevell, R. S.: Fundamentals of Flight. Prentice-Hall, 1983. • DIN 9300, Begriffe, Größen und Formelzeichen der Flugmechanik, Beuth-Verlag, Oktober 1990. • Battin, R. H.: An Introduction to the Mathematics and Methods of Astrodynamics. AIAA Education Series, 1987.	
Teaching method(s): Lecture	**Associated module examination:** 1. Prüfungsleistung Raumflugmechanik

Course: Strukturen und Systeme in der Raumfahrt	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 3,00	**University teacher:** Dr.-Ing. Jens Große Dipl.-Ing. Detlef Wilde
Literature: • Understanding Space, ISBN 0-07-057027-2 • Space Mission Analysis and Design, Larson und Wertz, ISBN 1-881883-01-9 • Human Spaceflight, Larson, ISBN 0-07-236811-X • Visualizing Project Management, K. Forsberg, ISBN 0-471-57779-0 • Kermode, A.C.: Mechanics of Flight. Longman Scientific & Technical, 1987. • Shevell, R. S.: Fundamentals of Flight. Prentice-Hall, 1983.	

• DIN 9300, Begriffe, Größen und Formelzeichen der Flugmechanik, Beuth-Verlag, Oktober 1990.

• Battin, R. H.: An Introduction to the Mathematics and Methods of Astrodynamics. AIAA Education Series, 1987.

Teaching method(s):	**Associated module examination:**
Lecture	2. Prüfungsleistung Strukturen und Systeme in der Raumfahrt

Module 01-PHY-MA-TANW-PHY-BP: Biophysik
Biophysics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Advanced Physics	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Dr. Ingolf Schäfer
Frequency:	**Duration:**
The module is valid since / The module is valid until: WiSe 22/23 / -	**Credit points / Workload:** 12 / 360 hours

Module examinations

Module examination: Graded Examination

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module examination: Study Achievements / Coursework

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module courses

Course: Praktikum

Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:**

Course: Vorlesung	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Lecture	**Associated module examination:**

Course: Seminar	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Seminar	**Associated module examination:**

Module 01-PHY-MA-TANW-PHY-CM: Computerunterstützte Materialwissenschaften
Computational Materials Science

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Physics / Advanced Physics	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Dr. Ingolf Schäfer
Frequency:	**Duration:**
The module is valid since / The module is valid until: WiSe 22/23 / -	**Credit points / Workload:** 12 / 360 hours

Module examinations

Module examination: Graded Examination

Type of examination:

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module examination: Study Achievements / Coursework

Type of examination:

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module courses

Course: Vorlesung

Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Lecture	**Associated module examination:**

Course: Vorlesung mit Übung	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s):	**Associated module examination:**

Course: Praktikum	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:**

Module 01-PHY-MA-TANW-PHY-FP: Festkörperphysik
Solid State Physics

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Physics / Advanced Physics	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Dr. Ingolf Schäfer
Frequency:	**Duration:**
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 22/23 / -	12 / 360 hours

Module examinations

Module examination: Graded Examination

Type of examination:

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module examination: Study Achievements / Coursework

Type of examination:

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module courses

Course: Vorlesung

Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Lecture	**Associated module examination:**

Course: Vorlesung mit Übung	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s):	**Associated module examination:**

Course: Seminar	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Seminar	**Associated module examination:**

Course: Praktikum	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:**

Module 01-PHY-MA-TANW-PHY-UP: Umweltphysik
Environmental Physics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Advanced Physics	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Dr. Ingolf Schäfer
Frequency:	**Duration:**
The module is valid since / The module is valid until: WiSe 22/23 / -	**Credit points / Workload:** 12 / 360 hours

Module examinations

Module examination: Graded Examination

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module examination: Study Achievements / Coursework

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Deutsch

Module courses

Course: Vorlesung mit Übung

Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s):	**Associated module examination:**

Course: Seminar	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Seminar	**Associated module examination:**

Course: Praktikum	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:**

Course: Vorlesung	
Frequency:	**Language(s) of instruction:** Deutsch
Contact hours: -	**University teacher:**
Teaching method(s): Lecture	**Associated module examination:**

Module 01-ET-BA-GIKT: Grundlagen der Informations- und Kommunikationstechnik
Introduction to Information and Communication Technology

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Information and Communication	Kenntnisse der Mathematik 1-4, Systemtheorie, Grundlagen der Informatik, Stochastik, Felder und Wellen, Theoretische Elektrotechnik

Learning content:

- Grundbegriffe der Nachrichten- und Informationstechnik
- Eigenschaften von Übertragungskanälen
- Darstellung von Quellensignalen (Abtastung, PAM, PCM, Quantisierung)
- Digitale lineare Modulationen (PSK, QAM)
- Lineare Empfängerkonzepte (Matched-Filter)
- Grundlagen der Kanalcodierung
- Grundlagen von Betriebssystemen
- Grundlagen von Kommunikationsprotokollen und Architekturen
- Grundlagen der Netzwerksicherheit
- Grundlagen des Software-Managements
- Grundbegriffe der Hochfrequenztechnik
- Grundlagen der Wellenausbreitung auf Leitungen
- Einführung in die Rechnung mit Streuparametern und Streumatrizen

Die Zusammenhänge und das Zusammenwirken obiger Themenbereiche werden anhand konkreter Systembeispiele aus der Kommunikationstechnik aufgezeigt und veranschaulicht.

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben

Learning outcomes / competencies / targeted competencies:
Die aus der Systemtheorie bekannten elementaren Grundlagen werden anhand ihrer Anwendung in der Nachrichtentechnik veranschaulicht. Grundsätzliche Kenntnisse der Übertragung von digitalen Signalen werden vermittelt.

Nach erfolgreichem Abschluss des Moduls

- sind die Studierenden mit den wichtigsten nachrichtentechnischen Konzepten vertraut,
- haben die Studierenden Erfahrungen im Umgang mit den mathematischen Hilfsmitteln der modernen Kommunikationstechnik gewonnen,
- besitzen sie einen Überblick über bestehende Übertragungs- und Kanalcodierungsverfahren,
- verstehen sie Betriebssysteme und deren Prozesse,
- verstehen sie, wie ein Compiler funktioniert und können einen eigenen, einfachen Compiler schreiben,
- verstehen sie den OSI Stack und können Beispiele für verschiedene Kommunikationsstandards geben und deren Unterschiede erklären,
- können sie einfache Kommunikationsprotokolle entwerfen und analysieren,
- verstehen sie Grundlagen der Daten- und Netzwerksicherheit,
- kennen sie die grundlegenden Begriffe der Hochfrequenztechnik,
- können sie die grundlegenden Verfahren zur Modellierung, mathematischen Beschreibung und Berechnung von Hochfrequenz-Wellenleitern und -Schaltungen anwenden,
- können sie die Reflexions- und Transmissionseigenschaften einfacher Hochfrequenzschaltungen berechnen,
- können sie einfache Schaltungen zur Anpassung von Hochfrequenzschaltungen entwerfen.

Anhand eines Systembeispiels aus der Kommunikationstechnik werden die Studierenden Grundkenntnisse und Kompetenzen in der Informations- und Kommunikationstechnik erlangen, von Betriebssystemen und Softwaremanagement über Kommunikationsprotokolle und Netzwerksicherheit bis zu Grundlagen von Übertragungs- und Kanalcodierungsverfahren sowie den Grundlagen der Hochfrequenztechnik.

Calculation of student workload:
84 h SWS / presence time / working hours
74 h Exam preparation
112 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction: German	**Responsible for the module:** Prof.Dr.-Ing. Armin Dekorsy
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 20/21 / -	**Credit points / Workload:** 9 / 270 hours

Module examinations

Module examination: Grundlagen der Hochfrequenztechnik

Type of examination: partial 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: Deutsch	

Module examination: Grundlagen der Nachrichtentechnik	
Type of examination: partial 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: Deutsch	

Module examination: Grundlagen der Informationstechnik	
Type of examination: partial 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: Deutsch	

Module courses

Course: Grundlagen der Hochfrequenztechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Martin Schneider
Teaching method(s):	**Associated module examination:** Grundlagen der Hochfrequenztechnik
Associated module courses **Grundlagen der Hochfrequenztechnik** (Lecture) **Grundlagen der Informationstechnik** (Lecture) **Grundlagenpraktikum Nachrichtentechnik** ()	

Course: Grundlagen der Informationstechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch

Contact hours: 2,00	**University teacher:** Prof. Dr. Anna Förster
Teaching method(s):	**Associated module examination:** Grundlagen der Nachrichtentechnik
Associated module courses **Grundlagenpraktikum Nachrichtentechnik** ()	

Course: Grundlagen der Nachrichtentechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Prof.Dr.-Ing. Armin Dekorsy
Teaching method(s):	**Associated module examination:** Grundlagen der Informationstechnik
Associated module courses **Grundlagen der Nachrichtentechnik** (Lecture) **Grundlagenpraktikum Nachrichtentechnik** ()	

Module 01-ET-MA-ADSP: Advanced Digital Signal Processing
Advanced Digital Signal Processing

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Information and Communication	Basics in Digital Signal Processing

Learning content:

- Linear MMSE and Least Square Estimation (Theory and Algorithms).
- Adaptive Filtering (LMS, NLMS, Affine Projection, RLS)
- Spectral analysis of stochastic processes (power spectrum density, Wiener-Chintschin-Theorem)
- Estimation of power spectrum density (estimation of autocorrelation function, periodogram, Bartlett-Welch method)
- Parametric estimation of power spectrum density
- Development of simulation models using Python and jupiter notebooks
- Basics in Linear Algebra
- Principle Component Analysis
- Compressed Sensing
- Finite Rate of Innovation
- Kalman Filter

Learning outcomes / competencies / targeted competencies:

After the course, the students will be able to

- understand the basics of linear estimation theory and algorithms (MMSE, Least Square);
- understand adaptive filters (LMS, NLMS, Affine projection, RLS);
- explain the basics of the traditional methods of spectral analysis for stochastic processes;
- understand the theoretical basics of parametric estimation procedures;
- develop and apply existing Python and jupiter notebooks;
- understand the basics of linear algebra and data/signal representation;
- understand the basics of sampling below the Nyquist rate with advanced methods such as compressed sensing and finite rate of innovation;
- understand advanced filtering methods such as the Kalman filter.

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?

no

Language(s) of instruction:	Responsible for the module:
English	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]

The module is valid since / The module is valid until:	Credit points / Workload:
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Oral	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch / German	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: Advanced Digital Signal Processing	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Dr.-Ing. Carsten Bockelmann Prof.Dr.-Ing. Armin Dekorsy
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-ET-MA-CNS(a): Communication Networks
Communication Networks

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Information and Communication • Technical Application Subject / Electrical Engineering / Sensors and Electronics	none

Learning content:
Distributed Systems, ISO/OSI 7 Layer Reference Model for Open Communication, Formal Specification Methods for Protocols (SDL), Data Link Layer, Network Layer, Transport Layer, Application Oriented Layers, Local Area Networks, Wide Area Networks, Network Control: (virtual) connections, Routing, Addressing, Flow Control, System Examples: TCP/IP, Wireless LAN, opportunistic and delay-tolerant networks.

Theoretical foundations of networking; queuing theory; graph theory, linear programming, network simulation basics.

Learning outcomes / competencies / targeted competencies:
The participants are able to describe exemplary systems of communication networks, name and explain the layers of a communication network, know the basic technologies used for communication protocols, know basic error handling mechanisms for communication protocols. The participants can analyze different network topologies and perform basic performance analysis of network protocols.

Calculation of student workload:
82 h Exam preparation
56 h Preparation / follow-up work
42 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Kombinationsprüfung	
Type of examination:	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Englisch
Description: Gemäß MPO-CIT-02-22 und AeO_MSc-CIT02-22 und MPO-WiIng-ET-IT-02-22 und AeO_MSc-WiIng-ET-IT-02-22, sowie MPO ET-IT-04-2020: Prüfungstyp: Kombinationsprüfung Anzahl Prüfungsleistungen: 2.

Module courses

Course: Communication Networks	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 3,00	**University teacher:** Dr. Andreas Könsgen Prof. Dr. Anna Förster
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung
Associated module courses **Communication Networks** (Lecture)	

Module 01-ET-MA-IKT1: Praktikum Informations- und Kommunikationstechnik I (IKT I) / Information and Communication Technolo

Information and Communication Technology Laboratory I (IKT I)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Information and Communication	none

Learning content:

The laboratory course “Information and Communication Technology Laboratory I“ is meant to provide the hands-on experience for the topics of the lectures offered by the Institute of Telecommunications and High Frequency Techniques. The module allows students to acquire the knowledge concerning the practical application of communication technology methods through labs on RF design, Communication Networks and Communication Technologies.

Learning outcomes / competencies / targeted competencies:

The students are able to apply theoretical knowledge and to interpret and document measurement results. They get to know modern simulating tools and measuring instruments.

Calculation of student workload:

34 h Self-study
28 h Preparation / follow-up work
28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination:

Form of examination:	**The examination is ungraded?**
Internship report	no

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

- / - / -

Language(s) of instruction:

Englisch / German

Description:
Anzahl Studienleistungen: 1.

Module courses

Course: Information and Communication Technology Laboratory

Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 2,00	**University teacher:** Dr.-Ing. Carsten Bockelmann Prof. Dr.-Ing. Martin Schneider Prof.Dr.-Ing. Armin Dekorsy Prof. Dr. Anna Förster
Literature: Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.	
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung

Associated module courses

Praktikum IKT I (Laboratory class)

Module 01-ET-MA-IKT2: Praktikum Informations- und Kommunikationstechnik II (IKT II) / Information and Communication Techno

Information and Communication Technology Lab II (IKT II)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Information and Communication	none

Learning content:

The laboratory course “Information and Communication Technology Laboratory 2“ is meant to provide the hands-on experience for the topics of the lectures offered by the Institute of Telecommunications and High Frequency Techniques. The module allows students to acquire the knowledge concerning the practical application of communication technology methods through labs on RF design, Communication Networks and Communication Technologies.

Learning outcomes / competencies / targeted competencies:

The students are able to apply theoretical knowledge and to interpret and document measurement results. They get to know modern simulating tools and measuring instruments.

Calculation of student workload:

34 h Self-study
28 h SWS / presence time / working hours
28 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof.Dr.-Ing. Armin Dekorsy
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	3 / 90 hours

This module is ungraded!

Module examinations

Module examination: Modulprüfung

Type of examination:

Form of examination:	**The examination is ungraded?**
Internship report	no

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

- / - / -

Language(s) of instruction:

Englisch / German

Description:
Anzahl Studienleistungen: 1.

Module courses

Course: Information and Communication Technology Laboratory 2	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 2,00	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung

Module 01-ET-MA-NetSim: Network Simulation
Network Simulation

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Information and Communication	none

Learning content:

- Discrete Event Simulation
- Radio transmission models
- Mobility models
- Traffic generation
- Interference models
- Power consumption and battery models
- OMNeT++
- Simulation speedup

A list of references will be provided at the start of the semester.

Learning outcomes / competencies / targeted competencies:

The goal of this lecture is to understand the design and programming of network simulators as well as the statistical evaluation of the results. The lecture provides a large amount of hands-on exercises where you will work with the OMNET simulator. We look at different types of networks, non-technical ones such as the spreading of biological viruses, traditional Internet-based networks and mobility-based opportunistic networks. Finally, you will work on a small project where you have to solve a given problem by means of simulations.

We expect from you some programming experience, preferably with C or C++.

After the lecture you will be able to design and develop simulation models of current and future networking technologies and identify resp. tackle performance issues in such networks

Calculation of student workload:

96 h Self-study
42 h Preparation / follow-up work
42 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English / German	Prof. Dr. Anna Förster
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Portfolio (AT § 8 Abs. 8)	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch / German	
Description: Anzahl Prüfungsleisungen: 1 (Homework, e-Klausur, Report, Presentation	

Module courses

Course: Network Simulation	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 3,00	**University teacher:** Prof. Dr. Anna Förster
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Network Simulation Theory** (Lecture)	

Module 01-PHY-MA-AMMDA: Applied Mathematical Methods and Data Analysis
Applied Mathematical Methods and Data Analysis

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:

The course lectures cover the theoretical and practical basis of the following subject areas:

PART A:

- Calculus I (Functions, theorems)
- Calculus II (Differentiations, applications of derivatives, approximations, errors)
- Calculus III (Integrations, applications of integrals)
- Calculus IV (Series, convergence, divergence)
- Differential equations I (ordinary first, second and higher-order differential equations - ODE)
- Differential equations II (partial differential equations - PDE)
- Exercises on all the above

PART B

- Introduction to Python (Installation, build-in functions, arrays, data loading, handling, visualizing)
- Hands – on examples (numerical approximations, differential equations)

References:

- Thomas Calculus 13th or 14th edition (Hass, Heil, Weir) Pearson
- Mathematical Methods in the Physical Sciences (Boas) Wiley

Learning outcomes / competencies / targeted competencies:

Introduction to essential and advanced mathematical methods (Part A) and applying these using the Python programming language. In the example classes (part B), students will learn how to apply the taught knowledge, both analytically and numerically. In order to facilitate the latter, students will learn the basics of the Python programming language and how to use Python to solve real-world problems from the course's topic areas.

Calculation of student workload:

56 h SWS / presence time / working hours
68 h Exam preparation
56 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Mihalis Vrekoussis
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]

The module is valid since / The module is valid until:	Credit points / Workload:
WiSe 20/21 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
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: Englisch	
Description: Examination performance: written exam (or as announced by the respective lecturer)	

Module courses

Course: lecture + example classes Applied Mathematical Methods and Data Analysis	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Applied Mathematical Methods and Data Analysis** (Lecture)	

Module 04-PT-MA-M11-BM1-ES: Basismodul 1 - ES - Einführung Energiesysteme und Grundlagen der elektrischen und chemischen Energiewandlung und Speicherung

Energy Transformation and -Storage

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Production Engineering / Energy Systems	Keine formalen Voraussetzungen, jedoch werden Kenntnisse aus den Grundlagen der Elektrotechnik (Drehstromsysteme, Leitungen) und aus den Grundlagen der Chemie (für Produktionstechniker) vorausgesetzt

Learning content:

A) Grundlagen der elektrischen Energietechnik

• Entwicklung der Elektroenergiesysteme

• Verbundnetze Lastprofile

• Erzeugung elektrischer Energie, CO2-Problematik

• Generatoren

• Elektrische Netze und Transport

• Leitungen

• Transformatoren

• Energiebedarf

• Aktuelle und zukünftige Entwicklung

• Verbundbetrieb

• Netzplanung

• Lastflussrechnung

• Netzanschlussregeln + EN50160

• Kurzschlussberechnung

B) Chemische Grundlagen der Energiewandlung und Speicherung

Ausgewählte Grundlagen der physikalischen und organischen Chemie werden an folgenden Beispielen erläutert

• Chemische Energiespeicherung mittels Katalyse: Methanisierung

• Wasserzerlegung

• Brennstoffzelltechnik

• Batteriesysteme

• Synthetische Treibstoffe

Learning outcomes / competencies / targeted competencies:
Nach erfolgreichem Abschluss des Moduls kennen die Studierenden

• die grundlegenden Eigenschaften, die Bau- und Betriebsweisen von Elektroenergiesystemen

• die Betriebsmittel der Elektroenergiesysteme

• die Grundlagen chemischer und elektrochemischer Energiewandlungsprozesse

Sie können

• einfache Netz- und Betriebsmittelberechnungen in elektrischen Energiesystemen durchführen

• Zusammenhänge von Quellen und Netzen berechnen.

• Grundlagen chemischer und elektrochemischer Energiewandlung selbstständig erarbeiten und aus Fachartikeln herauslesen, zusammenfassen und erklären

• den Einfluss der Katalyse und der er Thermodynamik auf die Wandlungsmechanismen beschreiben und kritisch diskutieren

• die Grundlagen beim kritischen Lesen von Fachartikel anwenden

• die Bedeutung chemischer Prozesse bei der Einführung nachhaltiger Energieversorgungskonzepte verstehen und kritisch diskutieren.

Calculation of student workload:
50 h Preparation / follow-up work
68 h Exam preparation
62 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr.-Ing. Jorg Thöming
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 14/15 / -	6 / 180 hours

Module examinations

Module examination: Fundamentals in Energy Engineering	
Type of examination: partial exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Deutsch

Module examination: Chemical Principles of Energy Conversion and Storage	
Type of examination: partial 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: Deutsch	

Module courses

Course: Grundlagen der Elektrischen Energietechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 3,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** 1. Prüfungsleistung Grundlagen der Elektrischen Energietechnik

Course: Chemische Grundlagen der Energiewandlung und Speicherung	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Seminar	**Associated module examination:** 2. Prüfungsleistung Chemische Grundlagen der Energiewandlung und Speicherung
Associated module courses **Chemische Grundlagen der Energiewandlung und Speicherung** (Lecture)	

Module 04-PT-MA-M11-BM2-ES: Basismodul 2 - ES - Thermische Grundlagen der Energietechnik und regenerative Energien

Thermal Fundamentals of Energy Engineering and Renewable Energies

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Production Engineering / Energy Systems	none

Learning content:

Thermal Energy Engineering

• Fundamentals of thermodynamics and energy engineering

• Energy sources, energy reserves and their assessment

• Power plants: Coal-fired steam turbine power plants, nuclear power plants, concentrating solar power plants, geothermal energy and geothermal power plants (organic rankine cycle, Kalina cycle), gas turbine power plants, combined cycle power plants

• Combined heat and power generation

• Vapour compression chillers, vapour absorption chillers, heat pumps, geothermal energy near the surface

Renewable Energies

• Principles for the usage of renewable energy types:

o Wind (on-/off-shore)

o Solar heat

o Photovoltaics

• Storage of renewable energies and fuel cells

• Fundamentals of the power grid integration: geographical availability of renewable energies and geographical demand

• Wind energy plants as a focus topic

o Setup (rotor, stator, drive train, generator, energy feed-in)

o Operation and maintenance (measurement and sensor systems)

• Fundamentals of flow measurement techniques for the development, monitoring and optimization of renewable energy systems

o Measurement principles:

- Thermographic flow visualization
- Pressure probes, hot wire probes
- Time-of-flight principles (L2F, PTV/PIV)
- Doppler principles (LDA, DGV)

o Field and laboratory investigations (in wind tunnels)

Learning outcomes / competencies / targeted competencies:
Thermal Energy Engineering

The students
• master the fundamentals of thermal and thermal to mechanical energy conversion processes and technologies.

• know the state of the art and future development opportunities of heat engines, combustion engines, refrigeration systems and heat pumps.

• understand and are able to evaluate state-of-the-art technologies and future opportunities for the usage of diverse energy sources, assess the efforts and risks associated with the usage of energy sources and identify potentials and restrictions for future usage of energy sources.

Renewable Energies

The students
• understand the working principles of the conversion of renewable energies, in particular wind energy, solar energy, to electrical and thermal energy.

• know the principle and application fields of different storage approaches for renewable energies.

• understand and are able to apply the fundamentals and principles of flow measurements for the operation, characterization and optimization of renewable energy systems.

Calculation of student workload:
42 h SWS / presence time / working hours
50 h Exam preparation
88 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr.-Ing. habil. Andreas Fischer
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 14/15 / -	6 / 180 hours

Module examinations

Module examination: Renewable Energy

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Oral examination (single)	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Deutsch

Module examination: Thermal Energy Engineering	
Type of examination: partial 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: Deutsch	

Module courses

Course: Regenerative Energien	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte, Springer, Berlin, Heidelberg 2013. • Wesselak, V., Schabbach, Th., Link, Th., Fischer, J.: “Handbuch Regenerative Energietechnik”, Springer-Verlag 2017. • Hau, E.: Windkraftanlagen, Springer Vieweg, Berlin, Heidelberg, 2016. • Nitsche, W., Brunn, A.: Strömungsmesstechnik, Springer-Verlag Berlin, Heidelberg, 2006.	
Teaching method(s): Lecture	**Associated module examination:** 1. Prüfungsleistung Regenerative Energien

Course: Thermische Energietechnik	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • Vorlesungsskript Thermische Energietechnik • Strauss, K.: Kraftwerkstechnik: zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer Vieweg, Berlin, Heidelberg 2016. • Zahoransky, R. (Hrsg.): Energietechnik: Systeme zur Energieumwandlung, Springer Vieweg, Wiesbaden 2015.	

• Lechner, Ch.; Seume, J. (Hrsg.): Stationäre Gasturbinen, Springer Vieweg, Berlin, Heidelberg 2019.	
Teaching method(s): Lecture	**Associated module examination:** 2. Prüfungsleistung Thermische Energietechnik

Module 01-PHY-MA-Dyn1: Dynamics I
Dynamics I

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:

- Governing equations
- Basic conservation laws
- Balances
- Elementary applications of the basic equations
- Circulation and vorticity
- Planetary boundary layer
- Rossby waves

References:

- Holton: An Introduction to Dynamic Meterorology, Elsevier Academic Press
- Marshall and Plumb: Atmosphere, Ocean, and Climate Dynamics, An Introductory Text, Academic Press, 2008
- Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Academic Press

Learning outcomes / competencies / targeted competencies:
Understanding of the basic dynamical processes in atmosphere and ocean; learning how to interpret physical equations physically

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?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Thomas Jung
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 20/21 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	The examination is ungraded?
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Englisch
Description: Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Dynamics I	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Dynamics I** (Lecture)	

Module 01-PHY-MA-Dyn2: Dynamics II
Dynamics II

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:
Fluid dynamics, ocean circulation, wind-driven and thermohaline circulation; atmosphere dynamics, dynamical system theory, non-dimensional parameters, bifurcations and instabilities; Gravity, Rossby and Kelvin waves; Conceptual models, Analytical and Programming techniques; Time series analysis.

References:

- Holton, J.R., Introduction to Dynamical Meteorology, Academic Press
- Gill, A., Atmosphere-Ocean Dynamics, Academic Press
- Dutton, J.A., The Ceaseless Wind, Dover
- Olbers, D.J., et al., Ocean Dynamics, Springer
- Cushman-Roisin, B. & Beckers, J.-M., Introduction to Geophysical Fluid Dynamics: Physical and Numerical Aspects

Learning outcomes / competencies / targeted competencies:
Advanced dynamics of the ocean and atmosphere, applications in the fields of climate dynamics and fluid mechanics. Programming skills (R studio) and usage of the climate data operators. Theoretical concepts in physics of climate, temporal and spatial scales of climate dynamics.

Calculation of student workload:
36 h SWS / presence time / working hours
10 h Exam preparation
44 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. rer. nat. Gerrit Lohmann
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 20/21 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:	The examination is ungraded?
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / 1 / -
Language(s) of instruction: Englisch
Description: Examination performance: written exam (or as announced by the respective lecturer) Course performance: portfolio (series of exercise sheets, calculation on blackboard)

Module courses

Course: lecture + example classes Dynamics II	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 3,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung

Module 01-PHY-MA-MES: Modelling of the Earth System
Modelling of the Earth System

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:

1. Types of models, linear vs. non-linear, box & complex models
2. Finite differences and spectral methods
3. Examples: waves, diffusion, boundaries
4. Finite Elements and spectral methods (atmosphere and ocean)
5. Model coupling (atmosphere and ocean)
6. Data assimilation (Kalman filters etc)
7. High-performance computing in modelling (scalability)
8. Random Systems (Stochastic equations, Lattice Gases)
9. Cryosphere (Sea ice, ice sheets, and permafrost)
10. Earth system models including tracers and dynamical vegetation
11. Chemistry Transport Models
12. Inverse methods in chemistry

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Theoretical concepts of Earth models; Applications

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?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. rer. nat. Gerrit Lohmann
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 20/21 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung	
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: Englisch
Description: Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Modelling of the Earth System	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-PHY-MA-MeTe: Measurement Techniques
Measurement Techniques

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Physics / Environmental Physics	Participation in the university's safety instructions and the fire drill is mandatory before getting access to the laboratories.

Learning content:
A set of practical measurements and computational experiments of meteorological quantities, atmospheric trace gases, ocean currents, ice thickness, and absorption cross-sections using different techniques is performed by the students under supervision of tutors. The measurements and data sets 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.

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Participants will perform measurements in Environmental Physics using scientific techniques and methods. They learn to analyse the measurements and to document the results in a written report.

Calculation of student workload:
42 h SWS / presence time / working hours
54 h Exam preparation
84 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	PD Dr. Andreas Richter
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 20/21 / -	6 / 180 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:	**The examination is ungraded?**
Oral	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
Englisch

Description:
Examination performance: oral exam Course performance: portfolio (series of successful experiments with accepted reports)

Module courses

Course: lecture + laboratory Measurement Techniques	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:**
Teaching method(s): Lecture Laboratory class	**Associated module examination:** Kombinationsprüfung

Module 01-PHY-MA-PhyO1: Physical Oceanography I
Physical Oceanography I

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:
External forcing (radiation, winds, tides), global distribution of important dynamic and physical parameters, water mass formation, wind-driven 3D circulation, geostrophy, meridional overturning, role of ocean in climate change

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Understand fundamentals of physical oceanography

Calculation of student workload:
68 h Exam preparation
56 h SWS / presence time / working hours
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Dr. Reiner Steinfeldt
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 20/21 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	The examination is ungraded?
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch

Description:
Examination performance: written exam (or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Physical Oceanography I	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Physical Oceanography I** (Lecture)	

Module 01-PHY-MA-RemS: Remote Sensing
Remote Sensing

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:
The course introduces the theoretical background of remote sensing methods (interaction of electromagnetic radiation with matter (spectroscopy), radiative transfer, principles of satellite remote sensing). Mostly passive (thermal emission, backscattered light) but also active (radar used in sea ice) remote sensing techniques and their data analysis (retrievals) are explained. This is illustrated by a large number of examples available and in use in the different research groups in the Institute of Environmental Physics (IUP).

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Basics of radiative transfer, spectroscopy, retrieval techniques. Overview of remote sensing from satellite, ground and airborne platforms in MW, IR and UV-VIS spectral range. Techniques in atmospheric remote sensing, sea ice remote sensing, ocean color remote sensing

Calculation of student workload:
28 h SWS / presence time / working hours
30 h Exam preparation
32 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Astrid Bracher
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 20/21 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:	The examination is ungraded?
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction: Englisch
Description: Examination performance: written exam (or as announced by the respective lecturer) Course performance: portfolio (series of exercise sheets or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Remote Sensing	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung

Module 05-GW-MA-MAG-GL1: Glaciology I
Glaciology I

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Geosciences	none

Learning content:
Glaciology deals with glaciers and ice sheets, from the physics of the natural medium ice and its various forms of appearance as well as the interaction of glaciers and ice sheets with climate and involved processes. For this understanding the interactions across interfaces at their top with the atmosphere and at their bottom with the underlying media. The rheologic properties of ice play an additional key role for the dynamic link of these interfaces. In this modul we will prepare the basic terminology and properties, introduce specific methods for the observation of change and dynamics as well as continuum mechanics and develop simple models for the description of the energy balance and ice dynamics. Apart from that we will specific properties of ice masses, in particular those of polar ice sheets as a climate archive. The docents to include the students' contribution before, during and after each lecture in a coordinated form into the curriculum. Presentation and discussion of exercises and exemplary studies will take wide room.

Learning outcomes / competencies / targeted competencies:
1) explain the interaction of the cryosphere with climate
2) describe the relevant processes
3) numerically reproduce these interactions with kinematic and simple dynamic models
4) understand and use the observational methods relevant for glaciology 5) understand glaciers and ice sheets as witnesses of paleo-conditions

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Angelika Humbert
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Glaciology I

Type of examination: module exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch
Description: 100 % written exam

Module courses

Course: Glaciologie I	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 3,00	**University teacher:**
Literature: Cuffey&Patterson, Physics of Glaciers, 2010 Benn & Evans, 'Glaciers and Glaciation', 2010 course manuscript	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Glaciology I
Associated module courses **Introduction to Glaciology** (Lecture)	

Course: Field Methods	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 2,00	**University teacher:**
Literature: 1) Field medhods in Glaciology: B. Hubbard and N. Glasser, Field Techniques in Glaciology and Glacial Geomorphology, ISBN 0470844272, J. Wiley & Son, 2005 2) The Physics of Glaciers, 4th Edition, Kurt Cuffey,W. S. B. Paterson, ISBN9780123694614, 2010, Imprint: Academic Press, Print Book ISBN: 9780123694614, eBook ISBN: 9780080919126 http://store.elsevier.com/The-Physics-of-Glaciers/Kurt-Cuffey/isbn-9780123694614/ The Physics of Glaciers, 4th Edition, Kurt Cuffey,W. S. B. Paterson, ISBN9780123694614, 2010 Imprint: Academic Press Print Book ISBN: 9780123694614 eBook ISBN: 9780080919126 http://store.elsevier.com/The-Physics-of-Glaciers/Kurt-Cuffey/isbn-9780123694614/	
Teaching method(s): Lecture Tutorial	**Associated module examination:**
Associated module courses **Field Methods in Glaciology** (Lecture)	

Module 05-GW-MA-MAG-GL2: Glaciology II
Glaciology II

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Geosciences	Glaciology I

Learning content:
The dynamics of ice sheets and glaciers can be described using continuum mechanics. Within this module, the general concept of continuum mechanics will be introduced. The governing equations of ice sheet dynamnics are derived and discussed. All this builds the foundation of ice sheet models, that will be the last part of the lecture. The lecture is accompanied by a seminar which is discussing the current hot topics in research of glaciers and ice sheets, ranging from observations of glacier systems to simulations of ice sheets.

Learning outcomes / competencies / targeted competencies:
1) understanding continuum mechanical concepts and their application to glaciology
2) gaining an understanding of ice sheet modelling
3) overview of current frontiers in Antarctic and Arctic glaciological research

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Angelika Humbert
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Glaciology II

Type of examination: module exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch

Description:
100 % written exam
Klausursprache wird in der LV nach Bedarf der Studierenden festgelegt, Klausur wird in nur einer Sprache angeboten

Module courses

Course: Theoretical Glaciology	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 3,00	**University teacher:**
Literature: Greve & Blatter `Dynamics of Glaciers and Ice Sheets`	
Teaching method(s): Lecture	**Associated module examination:** Glaciology II

Course: Remote sensing	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 2,00	**University teacher:**
Literature: Course manuscript, further literature is given during the lecture.	
Teaching method(s): Lecture	**Associated module examination:**

Module 05-GW-MA-MAG-GH1: Hazard - Risk Assessment
Hazard - Risk Assessment

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Geosciences	none

Learning content:
Geohazards, such as earthquakes, landslides, volcanic eruptions and flank collapses, and derived tsunamis, can have devastating effects on populations, economies and landscapes around the world. Understanding and developing effective and sustainable strategies to assess the risks and minimise the impacts of these hazards is and will increasingly become a major task for geoscientists. This module provides basic knowledge about the underpining geoprocesses. Such knowledge is essential in order to be able to develop sustainable strategies in the future.

Learning outcomes / competencies / targeted competencies:
1) gain an introduction and overview about submarine geohazards
2) understand earthquake mechanics and are able to compile risk maps
3) discriminate triggers of submarine landslides and analyse slope stability
4) evaluate generation modalities and impact of tsunami

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Katrin Huhn-Frehers
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 23/24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Hazard - Risk Assessment

Type of examination: module exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch

Description:
100 % Portfolio

Module courses

Course: catastrophic hazards	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 4,00	**University teacher:**
Literature: Stein & Wysession: An introduction to seismology, earthquakes, and earth structure Turcotte & Schubert: Geodynamics Loseth: Submarine mass flow sedimentation Saito: Tsunami generation and propagation	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Hazard - Risk Assessment
Associated module courses **Catastrophic Hazard Events** (Lecture)	

Module 05-GW-MA-MAG-GH2: Environmental Hazards
Environmental Hazards

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Geosciences	GIS course

Learning content:
Environmental hazards are widespread in marine and coastal environments. Physical coastal hazards include those caused by sea level changes and extreme storms. The immediate effect of these hazards is coastal retreat, that needs to be mapped and put into its historical context using both remote sensing and direct observations. The water column is then prone to a series of hazards, related to ocean chemistry (including pollutants). This module explore these different types of hazards and the techniques that are currently employed to study them.

Learning outcomes / competencies / targeted competencies:
know the basics of hazards related to sea level changes, extreme storms, coastal erosion and ocean-related hazards
are able to set up and run simple wave models (open source)
gain hands-on experience with typical direct measurement tools
acquire basic knowledge of ocean chemistry and different types of pollutants

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Dr. Marcello Gugliotta
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 23/24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Environmental Hazards

Type of examination: module exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch

Description:
100 % oral exam

Module courses

Course: physical coastal hazards	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 2,00	**University teacher:**
Literature: Church et al., 2010 -Understanding Sea?Level Rise and Variability - Wiley Bird et al., 2008 - Coastal Geomorphology: An Introduction, 2nd Edition - Wiley Scientific papers assigned by the lecturers	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Environmental Hazards

Course: Coastal erosion	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 1,00	**University teacher:**
Literature: Scientific papers and tutorials assigned by the lecturers	
Teaching method(s): Lecture Tutorial	**Associated module examination:**

Course: Ocean Chemistry	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 1,00	**University teacher:**
Literature: To be announced	
Teaching method(s): Lecture	**Associated module examination:**

Module 05-GW-MA-MAG-RE1: Renewable Energy Resources I - Renewable Energy in the Earth System

Renewable Energy Resources I - Renewable Energy in the Earth System

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Geosciences	none

Learning content:

Objective of the module is to give an overview of different renewable energy resources and ways of their exploitation. Covered energy resources include wind energy, ocean (wave and tidal) energy, geothermal and relief energy as well as radiation (solar) energy. Before elaborating on the specific resources, general principles of energy in the earth system are introduced. Based on this the principles behind the specific type of energy are discussed in dedicated blocks together with approaches for an assessment of the resource and further impacting factors. Corresponding methods, that are taught in the course and applied in exercises, include measurement concepts, numerical modelling and the quantitative analysis of relevant datasets.

Topics with respect to the exploitation of the respective type of renewable energy are covered in the seminar. Here, practical realizations are discussed with a focus on their technical and economic challenges.

Learning outcomes / competencies / targeted competencies:

know about general (physical) principles of energy in the earth system;
know about and evaluate different renewable energy resources;
know how to apply quantitative methods for assessing respective energy reosurces (based on dedicated measurement approaches and numerical modelling);
have an overview of approaches of renewable energy exploitation

Calculation of student workload:

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Volkhard Spieß
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 21 / -	6 / 180 hours

Module examinations

Module examination: Renewable Energy Resources I - Renewable Energy in the Earth System

Type of examination: combination exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

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

2 / - / -

Language(s) of instruction: Englisch
Description: 60 % written exam 40 % colloquium

Module courses

Course: Lecture	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 4,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Renewable Energy Resources I - Renewable Energy in the Earth System
Associated module courses **Renewable Energy in the Earth System** (Lecture)	

Course: Seminar	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 0,50	**University teacher:**
Teaching method(s): Seminar	**Associated module examination:**
Associated module courses **Renewable Energy Exploitation** (Seminar)	

Module 05-GW-MA-MAG-RE2: Renewable Energy Resources II - Offshore Wind Energy

Renewable Energy Resources II - Offshore Wind Energy

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Geosciences	none

Learning content:

Lecture / Seminar Block:
Principles of geophysical concepts for methods applied in the renewable offshore industry;
geophysical project planning with emphasis on the acquisiton, processing and interpretation of data;
joint Interpretation of typical geophysical data types incl. hydro-acoustic/seismoacoustic data in the in the framework of offshore construction work related of wind farms;
interdiscplinary analysis of geophysical and geotechnical data.
Project Block:
Planning of a model wind park based on geoscientific data sets
Planning of wind mill locations with respect to wind and subsurface data
Conceptual design of wind parks

Learning outcomes / competencies / targeted competencies:

Familiarization with geophyscial data interpretation (main focus on hydroacoustic and seismocacoustic data sets)
Qualitative and quantitative concepts of joint data interpretation (both different geophysical data types and geophysical/geotechnical data)
Basic understanding of geophysical project planning and geophysical workflows (acquisition/processing/interpretation)
[Add outcomes of Project.]

Calculation of student workload:

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Volkhard Spieß
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 21 / -	6 / 180 hours

Module examinations

Module examination: Renewable Energy Resources II - Offshore Wind Energy	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Englisch
Description: 100 % assignment

Module courses

Course: Lecture	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 3,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Renewable Energy Resources II - Offshore Wind Energy

Course: Project	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 1,00	**University teacher:**
Teaching method(s): Project	**Associated module examination:**

Module 05-GW-MA-MMG-CC1: Climate Change 1: Fundamentals
Climate Change 1: Fundamentals

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Geosciences	Basic knowledge in physical climatology, marine geology and programming

Learning content:
This first of two modules on climate change gives an overview of the basic components of the climate system, introduces nonlinear processes and feedbacks and proceeds from conceptual to comprehensive numerical models of the atmosphere, ocean, ice sheets and the Earth system. This is complemented by the paleoclimatic history of the Arctic and Antarctic polar regions during the Cenozoic and Pleistocene, which includes the tectonic development and its impact on the ocean circulation and high-latitude biota, as well as the development of polar ice sheets and their effects on sea level and global thermal differentiation. Computer and sediment lab exercises provide an introduction to scientific programming and data analysis on the one hand and high-latitude sediments on the other hand.

Learning outcomes / competencies / targeted competencies:
to obtain a basic understanding of the physics of the climate system
to get an overview of global climate development at tectonic to centennial time scales with an emphasis on the polar regions
to become able to assess the opportunities and limitations of numerical climate models and (paleo-) climate data
to acquire essential skills in scientific programming and data analysis

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Dr. André Paul
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Climate Change 1: Fundamentals

Type of examination: module exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch
Description: 100 % oral exam

Module courses

Course: Modelling	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:**
Literature: Hartmann, Dennis L.: Global Physical Climatology. Elsevier, 2nd edition, 498 pp., 2016. Open University: Ocean Circulation. Butterworth-Heinemann, 2nd revised edition, 286 pp., 2004. Ruddiman, W.F.: Earth's climate: past and future. W.H. Freeman, 3rd revised edition, 464 p., 2013.	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung MMG-CC1 Climate Change 1: Fundamentals
Associated module courses **Earth System Modelling** (Lecture)	

Course: high latitude oceans	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Literature: Hartmann, Dennis L.: Global Physical Climatology. Elsevier, 2nd edition, 498 pp., 2016. Open University: Ocean Circulation. Butterworth-Heinemann, 2nd revised edition, 286 pp., 2004. Ruddiman, W.F.: Earth's climate: past and future. W.H. Freeman, 3rd revised edition, 464 p., 2013.	
Teaching method(s): Lecture Tutorial	**Associated module examination:**
Associated module courses **The Role of High Latitudes Oceans in Climate Change** (Lecture)	

Module 05-GW-MA-MMG-CC2: Climate Change 2: Models and Data
Climate Change 2: Models and Data

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Geosciences	Contents of module Climate Change I

Learning content:
This second module introduces to the reconstruction and modeling of abrupt climate changes, provides an overview of paleo and historical climate changes (from the role of oceanic gateways in the Cenozoic through Pleistocene climate cycles to natural climate variability during the Holocene) and presents an outlook on future climate changes in response to projected anthropogenic climate forcings. Available evidence for past climate changes (from ice and marine sediment cores) as well as current climate change (from historical and instrumental data) is discussed. Computer lab exercises with conceptual climate models and results of comprehensive climate models are used throughout to investigate the processes that cause those climate changes.

Learning outcomes / competencies / targeted competencies:
to become familiar with the reconstructed climate variations for selected time intervals of the Cenozoic
to gain an understanding of the dynamics of abrupt climate changes
to analyze proxy data and compare them to the results of numerical climate models
to become able to assess the respective roles of natural and anthropogenic climate variations in past and future climate changes

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Dr. André Paul
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Climate Change 2: Models and Data

Type of examination: module exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch

Description:
100 % oral exam

Module courses

Course: Climate Changes	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 5,00	**University teacher:**
Literature: Alley et al.: Abrupt Climate Change: Inevitable Surprises. National Academy Press, Washington, DC, 238 pp., 2002. Ruddiman, W.F.: Earth’s climate: past and future. W.H. Freeman, 3rd revised edition, 464 p., 2013.	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung MMG-CC2 Climate Change 2: Models and Data

Module 01-ET-MA-CNSp: Communication Networks for Space
Communication Networks for Space

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	none

Learning content:
Introduction into communication networks. Internet protocols, Internet of things, wireless sensor networks, delay-tolerant networks, opportunistic networks. Space networks: types of spacecraft, orbits and paths, properties of space communication, types of data, quality-of-service requirements, space network architecture, protocols and bearer technologies for space networks, communication infrastructure of governmental and private space agencies.

References:

- J. Kurose/K. Ross: Computer Networking: A Top-Down Approach. 6th ed., Pearson Education, 2013.
- A. Förster: Wireless Sensor Networks. Wiley, 2016.
- J. Taylor: Deep Space Communications. Wiley, 2016.

Learning outcomes / competencies / targeted competencies:
The participants are able to describe exemplary systems of communication networks, know the basic design principles used for communication protocols on the different layers, can explain the special properties of space networks.

Calculation of student workload:
20 h Exam preparation
28 h Preparation / follow-up work
42 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung	
Type of examination:	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

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

Language(s) of instruction:
Englisch

Description:
ACHTUNG: Gemäß MPO-Space-ST-02-24

Prüfungstyp = Kombinationsprüfung; Anzahl Studienleistungen: 1,Anzahl Prüfungsleistungen: 1

(Course performance: Successful assessment of
homework assignments and a successful poster
preparation and presentation)

Module courses

Course: Communication Networks for Space

Frequency:	**Language(s) of instruction:**
winter semester, yearly	Englisch
Contact hours:	**University teacher:**
0,00	Dr. Andreas Könsgen Prof. Dr. Anna Förster

Literature:
• Walrand, J.: Communication Networks, A first course, WCB/McGraw-Hill 1998, ISBN 0-256-17404-0.
• Tanenbaum, A.S.: Computer Networks, Prentice Hall 1996, ISBN 0-13 349945-6 (and newer editions).
• Ross/Kurose, Computer Networking: A Top Down Approach, 4th ed., Addison-Wesley, July 2007

Teaching method(s):	**Associated module examination:**
Lecture	Kombinationsprüfung

Associated module courses

Communication Networks for Space (Lecture)

Module 01-ET-MA-CTh1(a): Control Theory 1 / Regelungstheorie 1

Control Theory 1

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies • Technical Application Subject / Electrical Engineering / Automation Technology • Technical Application Subject / Electrical Engineering / Renewable Energies	none

Learning content:

- Definition and features of state variables
- State space description of linear systems
- Normal forms
- Coordinate transformation
- General solution of a linear state space equation
- Lyapunov stability
- Controllability and observability
- Concept of state space control
- Steady-state accuracy of state space controllers
- Observer
- Controller design by pole placement
- Riccati controller design
- Falb-Wolovitch controller design

References:

- K. Michels: Control Engineering (Script in German and English)

German:

- J. Lunze: Regelungstechnik 2
- O. Föllinger: Regelungstechnik
- H. Unbehauen: Regelungstechnik II

English:

- Norman S. Nise: Control Systems Engineering

Learning outcomes / competencies / targeted competencies:

- Understanding and handling of state space methodology
- Design of state space controllers with different methods
- Observer design

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?

no

Language(s) of instruction: English / German	**Responsible for the module:** Prof. Dr.-Ing. Kai Michels
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / WiSe 24/25	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
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: - / - / -	
Language(s) of instruction: Englisch / German	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: Control Theory 1	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Kai Michels
Literature: K. Michels: Control Engineering (Script in German and English)	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Control Theory 1 / Regelungstheorie 1** (Lecture)	

Module 01-ET-MA-ComSp: Communication Technologies for Space
Communication Technologies for Space

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	Basics in linear algebra, calculus, differential equations, fourier transformation and physics (basics in electromagnetic waves) are recommended.

Learning content:

- Introduction to communications: history of wireless communication and space communication
- Basic concepts and terminology in communications
- Recap of Fourier transformation
- Introduction to system theory (signals, linear time invariant systems, convolution, statistic process, etc.)
- Passband-Baseband transformation and receiver concepts
- Wireless channel basics (linear and non-linear distortions, noise, Nyquist, etc.)
- Analog modulation
- Basics in sampling theory and discrete systems and signals
- Digital modulation
- Introduction to channel coding

Learning outcomes / competencies / targeted competencies:
As outcome, the students should be able to:

- explain basic communications concepts and theoretical foundations;
- apply mathematical tools and concepts relevant in communications;
- explain and apply analog and digital modulation.

Calculation of student workload:
56 h Self-study
68 h Exam preparation
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Dr.-Ing. Carsten Bockelmann
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 20 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung

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: - / - / -	
Language(s) of instruction: Englisch	
Description: Gemäß MPO-Space-ST-02-24, PL:1	

Module courses

Course: Communication Technologies for Space	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Dr.-Ing. Carsten Bockelmann
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Communication Technologies for Space** (Lecture)	

Module 01-ET-MA-DiTe(a): Digital Technology
Digital Technology

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies • Technical Application Subject / Electrical Engineering / Sensors and Electronics • Technical Application Subject / Electrical Engineering / Smart Electronic Systems	none

Learning content:

- Timing strategies
- Non-programmable hardware modules
- Programmable hardware modules
- Selected algregraic and Boolean operations
- Introduction to digital coding

Learning outcomes / competencies / targeted competencies:

Die Studierenden

- erlernen spezielle Fähigkeiten zur Realisierung funktionsspezifischer digitaler, kombinatorischer und komplexer sequentieller Schaltungen;
- erwerben Grundwissen zur Realisierung digitaler Module;
- erlernen verschiedene Strategien für die Realisierung digitaler Module (z.B. Datenpfad+Steuerpfad, Synchron vs. Asynchron, Programmierbarkeit, …);
- beherrschen Entwurfs- und Analysemethoden von Schaltnetzen und Schaltwerken;
- erlernen spezielle Fähigkeiten zur Realisierung funktionsspezifischer digitaler Systeme.

Calculation of student workload:

68 h Exam preparation
56 h SWS / presence time / working hours
56 h Self-study

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination:	
Form of examination: Written examination	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch / German	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: Digital Technology	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Alberto Garcia-Ortiz
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Digital Technology / Digitaltechnik** (Lecture)	

Module 01-ET-MA-EPC(a): Stromrichtertechnik
Electrical Power Converters

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Renewable Energies	none

Learning content:
Gleichstromsteller

Topologien, Ansteuerverfahren, Oberschwingungen, totzeitbedingte Spannungsfehler

Drehstrompulswechselrichter

Topologie, Funktionsweise und Modulationsverfahren

Netzgeführte Stromrichter mit Thyristoren

Stromrichtertopologien (einpulsige Grundschaltung, dreipulsige Mittelpunktschaltung, sechspulsige Brückenschaltung), Übertragungseigenschaften

Kommutierungsverhalten, Lückbetrieb

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcomes / competencies / targeted competencies:
Die Studierenden

- kennen Aufbau und Funktionsweise von leistungselektronischen Stromrichtern für den Einsatz in der Antriebs- und Energietechnik;
- beherrschen Steuerverfahren von selbst- und netzgeführten Stromrichtern;
- haben Kenntinsse über Oberschwingungen und Netzrückwirkungen durch Stromrichter.

Calculation of student workload:
42 h Preparation / follow-up work
68 h Exam preparation
70 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr.-Ing. Amir Ebrahimi
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination:

Form of examination: Written examination	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Deutsch	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: Stromrichtertechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 5,00	**University teacher:** Prof. Dr.-Ing. Amir Ebrahimi
Literature: Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.	
Teaching method(s): Lecture Tutorial Laboratory class	**Associated module examination:** Modulprüfung
Associated module courses **Stromrichtertechnik** (Lecture)	

Module 01-ET-MA-EPCL: Praktikum Stromrichtertechnik
Laboratory Electrical Power Converters

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Renewable Energies	none

Learning content:
Die Aufgabenstellungen orientieren sich inhaltlich an aktuellen Forschungsgebieten der elektrischen Energiewandlung in der elektrischen Energieversorgung in der Antriebstechnik und stellen so den direkten Praxisbezug her. Die konkreten Aufgabenstellungen werden individuell vereinbart.

Anhand einer vorgegebenen Aufgabenstellung werden den Studierenden die notwendigen wissenschaftlichen Methoden zur Einarbeitung in neue Themengebiete, Lösungsfindung, praktische Umsetzung sowie der entsprechenden Dokumentation vermittelt.

Learning outcomes / competencies / targeted competencies:
Im Rahmen des Praktikums lernen die Studierenden am Beispiel ihrer konkreten Aufgabe die Durchführung, Einordnung und Bewertung von Recherchen sowie die Nutzung der erzielten Ergebnisse für die Bearbeitung einer gestellten Aufgabe.

Das Praktikum vermittelt damit die Methodenkompetenzen, die für die erfolgreiche Bearbeitung der Masterarbeit im vorgegebenen Zeitrahmen erforderlich sind.

Calculation of student workload:
2 h Tutorial
28 h SWS / presence time / working hours
30 h Self-study
32 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr.-Ing. Amir Ebrahimi
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Portfolio (AT § 8 Abs. 8)	**The examination is ungraded?** no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Deutsch
Description: Anzahl Studienleistungen: 1 (mündlich)

Module courses

Course: Praktikum Stromrichtertechnik	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung
Associated module courses **Praktikum Stromrichtertechnik** (Laboratory class)	

Module 01-ET-MA-GG: Geodesy and Gravity
Geodesy and Gravity

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	none

Learning content:

Classical geodesy

- Repetition of Newtonian gravitational theory
- Multipole moments of the Earth and the gravitational field of the Earth
- Definition of the geoid on the rotating Earth
- Equation of motion for satellites
- Calculation of satellite orbits
- Description of orbits for satellite formation flight and extraction of the gravitational field

Relativistic geodesy

- Elements of relativistic gravity theory
- Post-Newtonian solution for the gravitational field of the Earth
- Definition of the geoid
- Clocks in the gravitational field: clock geodesy
- Relativistic satellite orbits, basic effects

Learning outcomes / competencies / targeted competencies:
The students gain knowledge of notions of nonrelativistic gravity theory, knowledge of basic notions of geodesy, an understanding of methods to measure the gravitational fields, knowledge of basic principles of relativistic gravity and an understanding of clock geodesy.

Calculation of student workload:
20 h Exam preparation
28 h SWS / presence time / working hours
42 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. rer. nat. Claus Lämmerzahl
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination:	
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: - / - / -	
Language(s) of instruction: Englisch	
Description: Gemäß MPO-Space-ST-02-24, Anzahl Prüfungsleistung: 1	

Module courses

Course: Geodesy and Gravity	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:** Prof. Dr. rer. nat. Claus Lämmerzahl
Teaching method(s): Lecture	**Associated module examination:** Modulprüfung
Associated module courses **Geodesy and Gravity** (Lecture)	

Module 01-ET-MA-GNSS: The Global Navigation Satellite System
The Global Navigation Satellite System

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	Newtonian mechanics

Learning content:

Understanding of the working principles of global navigation satellite systems (GNSS).

This consists on (i) the physical requirements regarding the main working principles. Here the Earth's gravity field, satellite orbits, clocks, electromagnetic signal propagation in the Earth's atmosphere, and the targeted accuracy are discussed.
In the second step (ii) the theoretical analysis of the whole problem has to be carried through. This includes basic effects on moving clocks (special relativistic time dilation) and clocks in gravitational fields (gravitational redshift) and the calculation of the position from the clock signals. Moreover, theoretical concepts within geodesy regarding reference surfaces and coordinate systems such as WGS84 will be introduced.
In the third part (iii) the technological realization is studied.

Learning outcomes / competencies / targeted competencies:

Physical and theoretical principles of positioning, navigation, GNSS satellites, payloads, clocks; Technology requirements of GNSS operation; Scientific use of GNSS

Calculation of student workload:

28 h Preparation / follow-up work
28 h SWS / presence time / working hours
34 h Exam preparation

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	Dr. Dennis Philipp
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	The examination is ungraded?
Written examination	no

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

1 / - / -

Language(s) of instruction:
Englisch / German

Module courses

Course: The Global Navigation Satellite System	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Literature: Werner Mansfeld: Satellitenortung und Navigation. Grundlagen, Wirkungsweisen und Anwendung globaler Satellitennavigationssysteme. Vieweg, Wiesbaden 2010. Manfred Bauer: Vermessung und Ortung mit Satelliten. Globale Navigationssysteme (GNSS) und andere satellitengestu¨tzte Navigationssysteme. Wichmann, Berlin 2011 B. Hoffmann-Wellenhof, H. Lichtenegger, and J. Collins: GPS - Theory and Practice, (Springer, Wien and New York, 2001) N. Ashby “Relativity in the Global Positioning System”, Living Reviews in Relativity P. Teunissen, O. Montenbruck “Springer Handbook of Global Navigation Satellite Systems”, Springer B. Hoffmann-Wellenhoff, H. Lichtenegger, E. Wasle “GNSS – Global Navigation Satellite Systems”, Springer ESA “GNSS data processing”, https://gssc.esa.int/navipedia/GNSS_Book/ESA_GNS S-Book_TM-23_Vol_I.pdf	
Teaching method(s): Lecture	**Associated module examination:** Modulprüfung

Module 01-ET-MA-LSpa1: Space Lab Part 1
Space Lab Part 1

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	-

Learning content:
A set of practical measurements and modelling experiments on surface properties, atmospheric trace gas amounts, ocean currents and other environmental parameters is performed by the students under supervision of tutors. The measurements and modelling 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.

Learning outcomes / competencies / targeted competencies:
Participants learn to perform measurements central to Space Sciences and Technologies using scientific techniques and methods. They learn to analyse the measurements and to document the results in a written report.

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	PD Dr. Andreas Richter
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 20 / -	3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction:
Englisch

Module courses

Course: Space Lab Part 1

Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Laboratory class	**Associated module examination:** Kombinationsprüfung

Module 01-ET-MA-LSpa2: Space Lab Part 2
Space Lab Part 2

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Physics / Spaces Sciences and Technologies	-

Learning content:
Application of control basics, measurements of Embedded Systems and Communications.

Learning outcomes / competencies / targeted competencies:
Participants learn

- the basics of control and measurement techniques in Space Sciences and Technologies;
- the basic structure and concepts of communications systems for space;
- implementation and visualization of communications algorithms and concepts via Matlab or Python;
- performance measurements of communication protocols using a simulation tool.

Calculation of student workload:

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Anna Förster
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 20 / -	3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
- / 1 / -

Language(s) of instruction:
Englisch

Module courses

Course: Space Lab Part 2

Frequency:	**Language(s) of instruction:**
winter semester, yearly	Englisch

Contact hours: 2,00	**University teacher:**
Teaching method(s): Lecture Laboratory class	**Associated module examination:** Modulprüfung
Associated module courses **Space Lab, Part 2** (Laboratory class)	

Module 01-ET-MA-NetDy(a): Dynamik und Stabilität in Übertragungsnetzen
Dynamics and stability in transmission grids

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Renewable Energies	none

Learning content:
- Modellbildung für Stabilitätsuntersuchungen
- Statische Stabilität
- Transiente Stabilität
- Dynamische Simulation
- Frequenz-Leistungsregelung
- Spannungsstabilität und -Regelung
- Flexible AC-Transmission Systems

Learning outcomes / competencies / targeted competencies:
Nach erfolgreichem Abschluss haben die Studierenden Kenntnisse über die Modellierung von elektrischen Energieübertragungssystemen für Stabilitätsbetrachtungen. Das dynamische Verhalten und die Stabilität können anhand der Modellierungen eigenständig berechnet und analysiert werden. In den Übungen sollen erste Kenntnisse über das dynamische Simulieren von Netzen vermittelt werden.

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?
no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr.-Ing. Johanna Myrzik
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulpüfung

Type of examination:

Form of examination:	The examination is ungraded?
Oral	no

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

Language(s) of instruction: Deutsch
Description: Anzahl Prüfungsleistungen: 1

Module courses

Course: Dezentrale Energieversorgung	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Johanna Myrzik
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulpüfung
Associated module courses **Dynamik und Stabilität in Übertragungsnetzen** (Lecture)	

Module 01-ET-MA-RFC(a): RF Frontend Devices and Circuits
RF Frontend Devices and Circuits

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Physics / Spaces Sciences and Technologies • Technical Application Subject / Electrical Engineering / Information and Communication	none

Learning content:

- Two-port circuits
- Noise in electronic circuits (thermal noise, noise figure, noise temperature, Friis formula, antenna noise, etc.)
- Fundamentals of non-linear devices (gain compression, desensitization, IP2, IP3 points, …)
- RF devices & RF circuits and frontends (amplifier, mixer, oscillator)

A list of references is given in the manuscript.

Learning outcomes / competencies / targeted competencies:

After successful completion of this module the students:

- can describe two-port circuits by matrices (Z, Y, ABCD, …)
- know the basic schematics of typical transmitter and receiver circuits
- can analyze the noise performance of receiver circuits
- can perform a signal and noise budget analysis of typical wireless communication links (microwave backhaul systems, mobile communications, satellite communications)
- can analyze the non-linear behavior of practical RF devices (amplifier, mixer)
- can design and analyze fundamental oscillator topologies
- are able to discuss the pros and cons of different RF frontend architectures and can design first basic analogue RF frontend circuits.

Calculation of student workload:

56 h SWS / presence time / working hours
68 h Exam preparation
56 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr.-Ing. Martin Schneider
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Written examination	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: RF Frontend Devices and Circuits	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Martin Schneider
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-ET-MA-RSOC: Remote Sensing of Ocean and Cryosphere
Remote Sensing of Ocean and Cryosphere

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	-

Learning content:

- Concepts for satellite remote sensing of the ocean and cryosphere
- Microwave radar and radiometer observations of sea and land ice and of sea surface temperature and salinity
- Altimetry for sea surface height, circulation, sea level and ice thickness change
- Optical satellite data for ocean color and sea ice
- Error analysis and statistics
- Practical examples and applications to use satellite data sets from oceanography and cryosphere
- Satellite data processing

A list of references will be provided at the start of the semester.

Learning outcomes / competencies / targeted competencies:
Students gain knowledge in basics and application of remote sensing of sea ice extent, type, drift and thickness, ice shelves and glaciers, sea surface height, winds over the ocean, waves, ocean color, surface temperature and salinity, sea level rise, ocean color and other remote sensing applications for ocean and cryosphere.

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?
no

Language(s) of instruction:	Responsible for the module:
English	Dr. Gunnar Spreen
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Prüfungsleistung

Type of examination:

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: - / - / -	
Language(s) of instruction: Englisch	
Description: ACHTUNG: Gemäß MPO-Space-ST-02-24, Prüfungstyp = Teilprüfung; Anzahl Studienleistung: 1, Anzahl Prüfungsleistung: 1 Prüfungsleistung: 3 CP Studienleistung: 3 CP	

Module examination: Studienleistung	
Type of examination:	
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: - / - / -	
Language(s) of instruction: Englisch	
Description: ACHTUNG: Gemäß MPO-Space-ST-02-24, Prüfungstyp = Teilprüfung; Anzahl Studienleistung: 1, Anzahl Prüfungsleistung: 1 Prüfungsleistung: 3 CP Studienleistung: 3 CP	

Module courses

Course: Remote Sensing of Ocean and Cryosphere	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Dr. Gunnar Spreen
Literature: A list of references will be provided at the start of the semester.	
Teaching method(s):	**Associated module examination:** Prüfungsleistung Studienleistung

Module 01-ET-MA-SAMS(a): Sensors and Measurement Systems
Sensors and Measurement Systems

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies • Technical Application Subject / Electrical Engineering / Sensors and Electronics • Technical Application Subject / Electrical Engineering / Smart Electronic Systems	none

Learning content:

The class will cover fundamentals of sensor science starting at the underlying physical mechanisms, different sensor devices, and integrated sensor systems. Process technology used to fabricate sensors will be discussed.

The following sensors will be addressed:

• Thermal Sensors

• Force and Pressure Sensors

• Inertial Sensors

• Magnetic Sensors

• Flow Sensors

Reference:

Walter Lang: Sensors and Measurement systems, ISBN-10: 877022028X

Learning outcomes / competencies / targeted competencies:

Students will gain an overview on different sensor technologies that will enable them to select a particular sensor for a defined application. They will be able to understand the working mechanism of various sensors and to make suggestions on how to improve their performance. Furthermore, they will be able to understand and optimize the different processing steps of a complex sensor module.

Calculation of student workload:

56 h SWS / presence time / working hours
56 h Preparation / follow-up work
68 h Exam preparation

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr.-Ing. Björn Lüssem
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]

The module is valid since / The module is valid until:	Credit points / Workload:
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Written examination	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch	
Description: Anzahl der Prüfungsleistungen: 1	

Module courses

Course: Sensors and Measurement Systems	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Björn Lüssem
Literature: Walter Lang: Sensors and Measurement systems, ISBN-10: 877022028X	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-ET-MA-SEM: Science and Exploration Missions
Science and Exploration Missions

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	none

Learning content:
Introduction to completed and planned space missions:

Examples are (i) Gravity Probe A for testing the gravitational redshift, (ii) Gravity Probe B for testing the gravitomagnetic Schiff effect, (iii) Cassini for Saturn exploration and testing the gravitational time delay, (iv) Pioneer for planetary exploration and testing the gravitational field in the Solar system, (v) MICROSCOPE for testing the Equivalence Principle, (vi) LISA for searching for gravitational waves and the technology mission LISA pathfinder, (vii) GRACE and GRACE-FO for satellite based geodesy, (viii) ACES on the ISS for testing relativity and establishing space-based metrology, (ix) further missions testing Special and General Relativity using quantum optics, (x) asteroid and comet missions HAYABUSA and Rosetta.

For each mission the requirements on the payload technology, the spacecraft technology, and on the mission scenario will be derived.

A list of references will be provided at the start of the semester.

Learning outcomes / competencies / targeted competencies:
Participants are able to discuss science cases for space and exploration missions, measurement schemes and payload as well as technology requirements on payload and mission.

Calculation of student workload:
28 h SWS / presence time / working hours
42 h Preparation / follow-up work
20 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. rer. nat. Claus Lämmerzahl
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination:

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Englisch
Description: Gemäß MPO-Space-ST-02-24: Anzahl Prüfungsleistung: 1

Module courses

Course: Science and Exploration Missions	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Literature: A list of references will be provided at the start of the semester.	
Teaching method(s): Lecture	**Associated module examination:** Modulprüfung
Associated module courses **Science and Exploration Missions** (Lecture)	

Module 01-ET-MA-SpEl(a): Space Electronics
Space Electronics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	Basic knowledge of semiconductors, analog and digital circuits

Learning content:

- Radiation environments
- MOS Device and radiation
- Circuit Reliability basics
- Single event effects on analog and digital circuits, memories
- Displacement damage (DD) effects
- Radiation hard device technologies and circuit design
- Noise
- gm/Id Method
- Mismatch
- Background on Analog and Digital simulation
- Process architecture
- Feedback

Learning outcomes / competencies / targeted competencies:

After this course, students are able to:

- describe and characterize noise in electronics circuits,
- apply the gm/Id sizing method to design amplifier circuits for advance CMOS technologies,
- deal with process variations and mismatch,
- understand the frequency behaviour of amplifier circuits,
- understand and size compensation networks,
- use feedback to modify circuit characteristics,
- understand the impact of radiation on the behavior of circuits,
- design radition-hard circuits.

Calculation of student workload:

68 h Exam preparation
56 h SWS / presence time / working hours
56 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Written examination	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Englisch	
Description: Gemäß MPO-Space-ST-02-24: Modulprüfung, PL:1	

Module courses

Course: Space Electronics	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Alberto Garcia-Ortiz
Teaching method(s): Lecture	**Associated module examination:** Modulprüfung
Associated module courses **Space Electronics** (Lecture)	

Module 01-ET-MA-WEAG: Windenergieanlagen - Grundlagen
Wind Power Converters - Foundations

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Renewable Energies	none

Learning content:

Das Modul besteht aus den zwei Bereichen

- Windenergieanlagen Grundlagen
- Anlagensteuerung und Überwachung

Teil 1:

- Der Wind (Meteorologie, Windhistogramme, Ertragsberechnung)
- Typologie und Funktion von Windenergieanlagen (WEA) (Windleistung, Betz-Limit, Auftriebs- und
- Widerstandsläufer, Horizontal- und Vertikal-Anlagen, elementare Funktionen)
- Aerodynamische Auslegung und aerodynamische Verluste
- Konstruktiver Aufbau I: Mechanik (Komponenten der WEA, Rotor bis Gründung)
- Kennlinien und Leistungsbegrenzung (Kennlinien für Leistung, Schub, Drehmoment, Leistungsbegrenzung und –regelung, Pitchregelung, Drehzahlregelung)
- Dynamische Belastungen (grundlegende Belastungen, Simulation von Belastungen, Ähnlichkeitstheorie)
- Wirtschaftlichkeit (Ertrag und Energiegestehungskosten, Energiepreis)

Teil 2:

- Elektrisches System
- Anlagenkonzepte (elektrische Grundlagen, vier Anlagenprinzipien)
- Sicherheitssystem
- Regelung
- Betriebsführung
- Fernüberwachung

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcomes / competencies / targeted competencies:

In der Vorlesung Windenergieanlagen-Grundlagen werden Grundlagen der Windenergienutzung vorgestellt und u. A. mit Hörsaalübungen praxisnah vertieft.

Nach Abschluss der Vorlesung sollen die Studenten und Studentinnen

- die physikalischen Grundlagen zur Windenergienutzung beschreiben können;
- die technischen Anlagenkonzepte erkennen und beschreiben können;
- die witschaftlichen Grundlagen der Windenergienutzung kennen;
- eine umfassende Übersicht zum Aufbau, der Funktion und der Konstruktion aller Teilkomponenten der gesamten Energiewandlungskette besitzen.

Calculation of student workload:

68 h Exam preparation
70 h SWS / presence time / working hours
42 h Preparation / follow-up work

Are there optional courses in the modules? no

Language(s) of instruction: German	**Responsible for the module:** Dr.-Ing. Holger Groke
Frequency: summer semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination: Oral	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Deutsch	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: Windenergieanlagen Grundlagen	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 5,00	**University teacher:** Dr.-Ing. Holger Groke Prof. Dr. Jan Wenske
Literature: Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-PHY-MA-AtCM1: Atmospheric Chemistry Modelling: Part 1 (Theory)
Atmospheric Chemistry Modelling: Part 1 (Theory)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	No formal requirements

Learning content:

- Concept of chemistry transport models
- Atmospheric Chemical Composition/Processes
- Model equations and numerical approaches focusing on the:
  a) formulation of atmospheric rates
  b) numerical methods for chemical systems
- Surface fluxes/emissions
- Observations and model evaluations
- Applied Mathematical Methods and Data Analysis for atmospheric chemistry

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Participants will have the chance to:

- get a theoretical overview of the concepts of numerical atmospheric chemistry modelling
- review fundamentals of atmospheric chemistry and physics
- formulate model equations and numerical (differential) approaches for various systems focusing on atmospheric chemistry mechanisms
- assess the role of chemistry transport models as components of the atmospheric observing system

Concepts of inverse modelling will be also presented

Calculation of student workload:
28 h SWS / presence time / working hours
20 h Exam preparation
42 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Mihalis Vrekoussis
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam	
Form of examination: Oral	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch	
Description: Examination performance: oral exam (or as announced by the respective lecturer)	

Module courses

Course: lecture + example classes Atmospheric Chemistry Modelling: Part 1 (Theory)	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Atmospheric Chemistry Modelling: Part 1 (Theory)** (Lecture)	

Module 01-PHY-MA-AtPhy: Atmospheric Physics
Atmospheric Physics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies • Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:

The origin of the solar system and the earth's atmosphere; the physical parameters, which determine the conditions in the atmosphere (e.g. temperature, pressure, and vorticity); the physical laws, which describe electromagnetic radiation; the interaction between electromagnetic radiation and matter (absorption, emission and scattering); atmospheric radiative transport; radiation balance, climate change; atmospheric thermodynamics and the hydrological cycle; aerosols and cloud physics; an introduction into atmospheric dynamics (kinematics, circulation etc.).

References:

- Houghton, J.T., The physics of atmospheres, Cambridge University Press, 1977, ISBN 0 521 29656 0.
- Wallace, John M. and Peter V. Hobbs, Atmospheric Science, An Introductory Survey, Academic Press, 2nd Edition 2005, ISBN 0-12-732951-x

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 and earth surface

b) learning the ability to apply the laws of physics to calculate parameters and forecast conditions in the atmosphere.

This knowledge is required for subsequent advanced courses in the M.Sc. program. These learning outcomes provide essential knowledge required for success in the following areas:

a) research in the atmospheric, environmental and climate sciences, meteorology, earth observation and remote sensing form ground based ship, aircraft and space based instrumentation,

b) employment in earth observation, meteorology, and education by industry, governmental and space agencies.

Calculation of student workload:

56 h SWS / presence time / working hours
56 h Preparation / follow-up work
68 h Exam preparation

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Hartmut Bösch

Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 23/24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung	
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: Englisch	
Description: Examination performance: written exam (or as announced by the respective lecturer)	

Module courses

Course: lecture + example classes Atmospheric Physics	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung
Associated module courses **Atmospheric Physics** (Lecture)	

Module 01-PHY-MA-AtSp: Atmospheric Spectroscopy
Atmospheric Spectroscopy

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	No formal requirements.

Learning content:

The lecture will discuss the basics of atmospheric spectroscopy. Atmospheric spectroscopy is directly related to molecular physics. Therefore, molecular physics will also play an important role in the lecture. Topics will be:

- What is light?
- Prism and grating spectrometer, Fourier Transform spectrometer
- Boltzmann distributions
- Uncertainty principle
- Rotation of molecules
- Vibration of molecules
- Electronic energy levels
- Transitions, transition rules, intensities
- Line widths
- Ground-based and satellite observations
- Retrieval of trace gas concentrations or temperature

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:

Basics of spectroscopy, basics of molecular spectroscopy. Understanding and interpretation of measured spectra with regard to the structure of the molecules. Basics of prism, grating and FTIR-spectroscopy, understanding of remote sensing methods.

Calculation of student workload:

28 h SWS / presence time / working hours
34 h Exam preparation
28 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. rer.nat. Justus Notholt
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	3 / 90 hours

Module examinations

Module examination: Modulprüfung	
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: Englisch	
Description: Examination performance: written or oral exam (as announced by the respective lecturer)	

Module courses

Course: lecture Atmospheric Spectroscopy	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Lecture	**Associated module examination:** Modulprüfung

Module 01-PHY-MA-CliS1: Climate System I
Climate System I

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Physics / Spaces Sciences and Technologies • Technical Application Subject / Physics / Environmental Physics	No formal requirements.

Learning content:

- Climate on earth
- The evolving climate system
- Energy balance models
- Radiation & convection
- Role of the ocean in climate
- Role of the cryosphere in climate
- Recent climate change
- The 1.5° warming threshold

A list of references will be provided in the course.

Learning outcomes / competencies / targeted competencies:
Climate physics

Calculation of student workload:
28 h SWS / presence time / working hours
34 h Exam preparation
28 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Torsten Kanzow
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination:	**The examination is ungraded?**
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / 1 / -

Language(s) of instruction: Englisch
Description: Examination performance: written exam (or as announced by the respective lecturer) Course performance: portfolio (series of exercise sheets or as announced by the respective lecturer)

Module courses

Course: lecture + example classes Climate System I	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung

Module 01-PHY-MA-DIP: Digital Image Processing
Digital Image Processing

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Physics / Spaces Sciences and Technologies	No formal requirements.

Learning content:

- Digital images, sampling
- Grey level transformations, color images
- Image enhancement using filters
- Image analysis methods using segmentation, feature extraction and classification
- Fourier transformation of digital images, linear filters in spatial and frequency domains
- Data compression, image coding, image formats

References:

- K. R. Castleman: Digital Image Processing. Prentice Hall, Englewood Cliffs, 1996.
- R. C. Gonzalez, R. E. Woods: Digital Image Processing. Addison-Wesley, Second Edition, 2002.
- B. Jähne: Digital Image Processing. Springer, 2002.
- J.C. Russ: The Image Processing Handbook, 5th Edision. CRC Press, 2006 (ISBN 0-8493-7254-2).
- R. A. Schowengerdt: Remote Sensing, Models and Methods for Image Processing. Academic Press, 1997.

Learning outcomes / competencies / targeted competencies:
Fundamentals, basic concept and methods of digital image processing, enabling the students to identify and understand image processing problems (encountered in Environmental Physics, Space Science etc.) and to find appropriate solutions

Calculation of student workload:
28 h Preparation / follow-up work
28 h SWS / presence time / working hours
34 h Exam preparation

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Dr. Gunnar Spreen
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 20/21 / -	3 / 90 hours

Module examinations

Module examination: Kombinationsprüfung

Type of examination: combination exam

Form of examination: Written examination	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / 1 / -	
Language(s) of instruction: Englisch	
Description: Examination performance: written exam (or as announced by the respective lecturer) Course performance: portfolio (series of exercise sheets or as announced by the respective lecturer)	

Module courses

Course: lecture + example classes Digital Image Processing	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Lecture Tutorial	**Associated module examination:** Kombinationsprüfung

Module 03-INF-BA-IBAP: Aufbau Praktische Informatik
Aufbau Praktische Informatik

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	Depending on the chosen course, there is the possibility that knowledge from foundational Computer Science modules will be required.

Learning content:
The module content depends on the chosen course.

Learning outcomes / competencies / targeted competencies:
Students build on the skills and knowledge they have acquired in the foundation modules and develop a basic understanding of a sub-area of practical computer science. They are familiar with specific methods for developing software in a specific domain - (architectural) concepts, modeling procedures and/or algorithms - and can apply these to simple tasks. The skills acquired will form the basis of prerequisite knowledge for further in-depth courses in the respective fields. The specific competencies depend on the chosen course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The current courses on offer are:

- 03-IBAP-BS Betriebssysteme
- 03-IBAP-CS Cognitive Systems
- 03-IBAP-CG Computergraphik
- 03-IBAP-DBS Datenbanksysteme
- 03-IBAP-DSMS Domänenspezifische Modellierung und Sprachen
- 03-IBAP-KI Grundlagen der Künstlichen Intelligenz
- 03-IBAP-ML Grundlagen des Maschinellen Lernens
- 03-IBAP-ISEC Informationssicherheit
- 03-IBAP-MRCA Modern Robot Control Architectures
- 03-IBAP-RA Rechnerarchitektur und eingebettete Systeme
- 03-IBAP-RN Rechnernetze
- 03-IBAP-SDV Sensordatenverarbeitung
- 03-IBAP-SWT Softwaretechnik
- 03-IBAP-ÜB Übersetzerbau

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/ibap

(The courses on offer will be updated depending on the capacities of available personnel.)

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]

The module is valid since / The module is valid until:	Credit points / Workload:
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
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: Deutsch / English (Je nach gewählter Lehrveranstaltung.)	
Description: Will be decided upon by the Lecturer of the specific course: Portfolio, Presentation + Research paper, Term paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Aufbau Praktische Informatik	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Es gibt sowohl deutschsprachige als auch englischsprachige Wahlalternativen)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The Literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung

Associated module courses

Betriebssysteme (Lecture)

Computergraphik (Lecture)

Datenbanksysteme (Lecture)

Formale Beweismethoden (Lecture)

Informationssicherheit (Lecture)

Rechnerarchitektur und Eingebettete Systeme (Lecture)

Module 04-PT-MA-M11-BM1-AM: Basismodul 1 - AM - Mechanik
Mechanics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Production Engineering / General Mechanical Engineering	

Learning content:
• Stress states, strain states, elastic constitutive relation, boundary value problems, solution strategies

• Conservation of mass and linear momentum, potential theory, shear and rotational flow, ideal and viscous flow, dimensional analysis, turbulent boundary layer flow

Learning outcomes / competencies / targeted competencies:
• Basic knowledge in the field of three-dimensional elasticity theory

• Understanding the mass and linear momentum conservation equations (Navier-Stokes equations) as a prerequisite for the meaningful application of numerical methods and for the mechanical interpretation of numerical results

Calculation of student workload:
56 h SWS / presence time / working hours
68 h Exam preparation
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr. Marc Avila
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 13/14 / -	6 / 180 hours

Module examinations

Module examination: Introduction into Fluid Mechanics

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Description:
3 CP/90 h

Module examination: Higher Strength Theory and Structural Mechanics in Lightweight Construction

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Description:
3 CP/90 h

Module courses

Course: Einführung in die Strömungslehre

Frequency:	**Language(s) of instruction:**
winter semester, yearly	Deutsch
Contact hours:	**University teacher:**
2,00	

Literature:
• Joseph Spurk, Nuri Aksel: Strömungslehre - Einführung in die Theorie der Strömungen, 9. Auflage, Springer Vieweg 2019

• Hydromechanik, Elemente der Höheren Mechanik, Numerische Methoden, Springer, Berlin 2009

• R. Kienzler, R. Schröder: Einführung in die höhere Festigkeitslehre,
Springer Heidelberg 2009

Teaching method(s):	**Associated module examination:**
Lecture	1. Prüfungsleistung Einführung in die Strömungslehre

Associated module courses

Einführung in die Strömungslehre (Lecture)

Course: Höhere Festigkeitslehre und Strukturmechanik im Leichtbau (ehemals Einführung in die höhere Festigkeitslehre)

Frequency:	**Language(s) of instruction:**
winter semester, yearly	Deutsch
Contact hours:	**University teacher:**
2,00	

Literature:
• Joseph Spurk, Nuri Aksel: Strömungslehre - Einführung in die Theorie der Strömungen, 9. Auflage, Springer Vieweg 2019

• Hydromechanik, Elemente der Höheren Mechanik, Numerische Methoden, Springer, Berlin 2009

• R. Kienzler, R. Schröder: Einführung in die höhere Festigkeitslehre,
Springer Heidelberg 2009

Teaching method(s):	**Associated module examination:**
Lecture	2. Prüfungsleistung Höhere Festigkeitslehre und Strukturmechanik im Leichtbau (ehemals Einführung in die höhere Festigkeitslehre)

Associated module courses

Höhere Festigkeitslehre und Strukturmechanik im Leichtbau (Lecture)

Höhere Festigkeitslehre und Strukturmechanik im Leichtbau-Übung (Tutorial)

Module 04-PT-MA-M11-BM2-AM / M11-BM2-IM: Basismodul 2 - AM/IM - Konstruktionsmethodik

Design Methodology

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Production Engineering / General Mechanical Engineering • Technical Application Subject / Production Engineering / Industrial Management	

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:
56 h SWS / presence time / working hours
60 h Exam preparation
64 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr.-Ing. habil. Klaus-Dieter Thoben
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 13/14 / -	6 / 180 hours

Module examinations

Module examination: Introduction to Design Methodology

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Application of Design Methods

Type of examination: partial 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: Deutsch	

Module courses

Course: Einführung in die Konstruktionsmethodik	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature:	
Teaching method(s): Lecture	**Associated module examination:** 1. Prüfungsleistung Einführung in die Konstruktionsmethodik

Course: Anwendung von Konstruktionsmethoden	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Teaching method(s): Tutorial	**Associated module examination:** 2. Prüfungsleistung Anwendung von Konstruktionsmethoden

Module 03-INF-MA-IMK-AI: Kern (AI)
Core (AI)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:

1. The modeling of intelligent systems as "rational agents"
2. Problem solving with search algorithms
    - heuristic search, constraint-based search, optimizing search
3. Problem solving through logic-based representation and reasoning systems (symbolic knowledge representation)
    - propositional and predicate logic-based WR + ontologies (description logics)
    - brief discussion of common-sense reasoning (frame, qualification, & ramification problem)
    - action planning
4. Probabilistic problem solving
    - Bayes nets (inference and learning)
    - Markov decision processes
5. Problem solving with the help of machine learning

Learning outcomes / competencies / targeted competencies:

- Be able to practically apply the basic procedures, methods and approaches of artificial intelligence
- Gain specialist expertise in particular, but not exclusively, in the areas of search, logic, planning and machine learning
- Master the terminology of the subject area
- Be able to classify the individual methods/approaches of AI in a wider context
- Be able to classify the subject area (or parts of the subject area) in the context of other disciplines
- Be able to transfer basic procedures to individual concrete task situations and solve them

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German / English	Prof. Ph.D. Michael Beetz
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 23/24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung	
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: - / - / -	
Language(s) of instruction: Deutsch / English (Je nach gewählter Lehrveranstaltung)	
Description: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Kern (AI)	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch / English (Abhängig von der besuchten Lehrveranstaltung)
Contact hours: 4,00	**University teacher:** Prof. Ph.D. Michael Beetz
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Advanced Methods of AI** (Lecture)	

Module 03-INF-MA-IMK-DMI: Kern (DMI)
Kern (DMI)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:
Entertainment computing is a diverse and complex applied field that combines many areas of computer science in addition to creative aspects. The course content therefore includes interaction design, graphic design and dramaturgy of entertainment computing applications as well as the technical basics from the fields of HCI, 3D computer graphics, game AI and game engine design.

The aim is to teach application-oriented content from various areas of entertainment computing. This includes design aspects (e.g. game/story design, interaction design, etc.) as well as technical knowledge (e.g. game engines, real-time rendering or digital content creation tools). Various application areas of entertainment technologies are covered, e.g. serious games or mixed reality performances. Participants will also gain practical experience with industry established tools.

Learning outcomes / competencies / targeted competencies:
The students have:

- An understanding of the basic concepts of entertainment computing such as game engines, game loops, game mechanics, etc.
- Knowledge of the basic theories of games
- The ability to analyze games in relation to the concepts implemented in them
- The ability to use game development tools sensibly
- Understood and gained practical experience with game development workflows
- Knowledge of typical roles and methods in the professional production of games
- Knowledge of and the ability to apply game evaluation methods
- Knowledge of fields of application of games and understanding of concepts of serious games

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof.Dr. Rainer Malaka
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
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: Englisch	
Description: Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Kern (DMI)	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Prof.Dr. Rainer Malaka
Teaching method(s):	**Associated module examination:** Modulprüfung

Module 03-INF-MA-IMK-SQ: Kern (SQ)
Kern (SQ)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:
- The concept of dependability;
- Aspects of the concept of quality;
- Legal aspects, norms and standards, such as the functional safety standard IEC 61508 and the Common Criteria IEC 15408;
- Software development models, risk analyses;
- Classification of security attacks;
- Formal modeling with SysML and OCL;
- Verification techniques: Testing, static program analysis, formal verification, model checking

Learning outcomes / competencies / targeted competencies:
- Developing a basic understanding of system safety (Safety&Security);
- Understanding the legal basis, norms and standards in the development of such systems;
- Mastering and applying basic techniques for the development of safety-critical systems. This includes formal modeling languages for the specification of properties, and verification methods such as testing, static program analysis, program verification and model checking.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Dr. Christoph Lüth
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 23/24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Deutsch
Description: Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Kern (SQ)	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 4,00	**University teacher:** Prof. Dr. Dieter Hutter Dr. Christoph Lüth
Literature: • D. Smith & K.G.L. Simpson: Functional Safety. Elsevier, 2001 • Nancy G. Leveson: SAFEWARE: SYSTEM SAFETY AND COMPUTERS. Addison-Wesley ISBN: 0-201-11972-2. • N. Storey: Safety-Critical Computer Systems. Addison Wesley Longman 1996. • Dieter Gollmann: Computer Security, 2nd edition, Wiley and Sons, 2006 • Edmund M. Clarke, Orna Grumberg and Doron A. Peled: Model Checking, The MIT Press, 1999	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Systeme hoher Sicherheit und Qualität** (Lecture)	

Module 03-INF-MA-IMK-VMC: Kern (VMC)
Kern (VMC)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:
Image processing with deep learning.

The formal definitions of all of the following topics are covered as well as an intuitive understanding of the ideas behind them, their meaning within the general subject area and the interaction between them.

- Paradigms "analytically developed" vs. "machine-learned"
- The architecture of image processing neural networks ("big picture" - overview without the details that follow later)
- Forms of output: classification, semantic segmentation, heatmaps, bounding boxes, object ID per pixel, application-dependent values
- Layers: Convolution, Activation, Pooling, Unpooling, Fully Connected
- Losses: absolute, quadratic, relative error, maximum likelihood, cross entropy, weighting, combination of several losses
- Optimization by gradient descent, view of a network with the loss as a graph of tensor operations, tensor formats, backpropagation on such a graph
- Receptive field as an architectural parameter
- Typical CNN backbone architectures and their use in the "pretrained" approach
- Decoder-encoder architecture for images as output, meaning of cross-connections
- Object recognition: output form for bounding boxes, one-shot vs. two-shot approach
- Procedure for data acquisition and processing
- Procedure for the development and evaluation of deep learning image processing systems
- Media applications of deep learning, especially for image generation
- Generative adversarial networks (the basic idea)

3D image processing

- Paradigm of "pixels to meters by equation solving"
- Point features
- Camera equations
- Geometric reconstruction (which 3D features can be reconstructed from how many 2D point pairs)
- Quadratic adjustment calculation as a generic algorithmic approach for geometric reconstruction
- Particle filters for temporal processes, the role that image processing plays as a measurement model

Learning outcomes / competencies / targeted competencies:
Understanding the most important methods of modern image processing

- Image processing within deep learning (convolutional neural networks)
- 3D image processing ("from pixels to meters")

Be able to solve application problems with these methods

- Design suitable processing chains for application problems
- Formulate practical problems as deep learning tasks
- Obtain and prepare training data
- Model three-dimensional geometric relationships in images
- Systematically develop deep learning and 3D image processing systems
- Implementation with TensorFlow / Keras and OpenCV

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr. Udo Frese
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Description:
Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Kern (VMC)

Frequency:	**Language(s) of instruction:**
summer semester, yearly	Deutsch

Contact hours: 4,00	**University teacher:** Prof. Dr. Udo Frese
Literature: • MIT 6.S191, Introduction to Deep Learning, http://introtodeeplearning.com • Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016 (http://www.deeplearningbook.org) • Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision (https://www.robots.ox.ac.uk/~vgg/hzbook/) • Richard Szeliski, Computer Vision and Applications, Springer 2010 (http://szeliski.org/Book/, Computer Vision vor der Deep Learning Revolution)	
Teaching method(s):	**Associated module examination:** Modulprüfung

Module 03-INF-MA-IMA-AI: Aufbau Informatik (AI)

Aufbau Informatik (AI)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire a research-oriented basic understanding of a sub-area of theoretical, practical or applied computer science in the field of Artificial Intelligence. The skills acquired are a prerequisite for in-depth modules in the respective sub-area. The specific skills depend on the courses chosen.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module (if not already taken in another module). Courses currently on offer:

- 03-IMAT-AU Algorithms and Uncertainty
- 03-IMAP-ASE Automatische Spracherkennung
- 03-IMAT-BL Beschreibungslogik
- 03-IMAP-CM Cognitive Modeling
- 03-IMAP-IIS Integrated Intelligent Systems
- 03-IMAA-ITMDS IT-Management & Data Science
- 03-IMAP-RL Reinforcement Learning
- 03-IMAP-SECORO Software Engineering for Cognitive Robots
- 03-IMAP-UUW Umgang mit unsicherem Wissen

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/imsp/ima-ai

(The offered courses will be updated depending on available personnel)

Language(s) of instruction:	Responsible for the module:
English / German	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
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: Englisch / German (Je nach gewählter Lehrveranstaltung)	
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Aufbau Informatik (AI)	
Frequency: each semester	**Language(s) of instruction:** Englisch / German (Neben englischsprachigen Wahlalternativen kann es auch deutschsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Algorithms and Uncertainty** () **Automatische Spracherkennung** (Lecture) **IT-Management und Data Science** (Lecture) **Integrated Intelligent Systems** (Lecture)	

Module 03-INF-MA-IMA-DMI: Aufbau Informatik (DMI)
Aufbau Informatik (DMI)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire a research-oriented basic understanding of a sub-area of theoretical, practical or applied computer science in the field of Digital Media and Interaction. The skills acquired are a prerequisite for in-depth modules in the respective sub-area. The specific skills depend on the courses chosen.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module (if not already taken in another module). Courses currently on offer:

- 03-IMAA-CTHCI Current Topics in HCI
- 03-IMAA-MITR Medien- und IT-Recht
- 03-IMAA-MAD Mobile App Development
- In addition, course alternative(s) in module IMAP-DMI not taken elsewhere.

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/imsp/ima-dmi

(The offered courses will be updated depending on available personnel)

Language(s) of instruction:	Responsible for the module:
English / German	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Englisch / German (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Aufbau Informatik (DMI)	
Frequency: each semester	**Language(s) of instruction:** Englisch / German (Neben englischsprachigen Wahlalternativen kann es auch deutschsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Medien- und IT-Recht** () **Mobile App Development** (Lecture)	

Module 03-INF-MA-IMA-SQ: Aufbau Informatik (SQ)
Aufbau Informatik (SQ)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire a research-oriented basic understanding of a sub-area of theoretical, practical or applied computer science in the field of Information Security and/or Software Quality. The skills acquired are a prerequisite for in-depth modules in the respective sub-area. The specific skills depend on the courses chosen.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module (if not already taken in another module). Courses currently on offer:

- 03-IMAT-APX Approximation Algorithms
- 03-IMAT-AU Algorithms and Uncertainty
- 03-IMAT-GSD Grundlagen der Sicherheitsanalyse und des Designs
- 03-IMAT-IRQ Introduction to Reversible and Quantum Computing
- 03-IMAT-KRYPT Einführung in die Kryptographie
- 03-IMAA-ITMDS IT-Management & Data Science
- In addition, course alternative(s) in module IMAP-SQ not taken elsewhere.

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/imsp/ima-sq

(The offered courses will be updated depending on available personnel)

Language(s) of instruction:	Responsible for the module:
German / English	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

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: Deutsch / English (Je nach gewählter Lehrveranstaltung)	
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Aufbau Informatik (SQ)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Neben deutschsprachigen Wahlalternativen kann es auch englischsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Einführung in die Kryptographie** () **IT-Management und Data Science** (Lecture) **Software-Reengineering** (Lecture)	

Module 03-INF-MA-IMA-VMC: Aufbau Informatik (VMC)

Aufbau Informatik (VMC)

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Computer Science	none

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire a research-oriented basic understanding of a sub-area of theoretical, practical or applied computer science in the field of Visual Computing and/or Medical Computing. The skills acquired are a prerequisite for in-depth modules in the respective sub-area. The specific skills depend on the courses chosen.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module (if not already taken in another module). Courses currently on offer:

- 03-IMAP-AML Advanced Machine Learning
- 03-IMAA-CTHCI Current Topics in HCI
- 03-IMAA-EC Entertainment Computing
- 03-IMAA-HCIT Healthcare IT
- In addition, course alternative(s) in module IMAP-VMC not taken elsewhere.

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/imsp/ima-vmc

(The offered courses will be updated depending on available personnel)

Language(s) of instruction:	Responsible for the module:
German / English	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

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: Deutsch / English (Je nach gewählter Lehrveranstaltung)	
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Aufbau Informatik (VMC)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Es gibt sowohl deutschsprachige als auch englischsprachige Wahlalternativen)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Advanced Machine Learning** (Lecture) **Advanced Methods of AI** (Lecture)	

Module 03-INF-MA-IMAP-AI: Aufbau Praktische Informatik (AI)

Aufbau Praktische Informatik (AI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	none

Learning content:

- CNNs and architectures based on them (image processing, medical BV)
- Reinforcement learning (robot control)
- Recurrent Neural Networks (audio processing, general signal processing)
- Multimodal Data

Learning outcomes / competencies / targeted competencies:

The students

- Have an understanding of modern machine learning methods and how they can be applied to various problems.
- Are able to solve application problems with these methods by modeling the problem in the context of machine learning, collecting and processing data and systematically developing a machine learning solution based on existing software frameworks.
- Are able to consider and incorporate certain requirements and problems from a methodological, software and application technology perspective.

Calculation of student workload:

124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr. Tanja Schultz
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

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

1 / - / -

Language(s) of instruction: Englisch
Description: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Aufbau Praktische Informatik (AI)	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Prof. Dr. Tanja Schultz
Literature: • MIT 6.S191, Introduction to Deep Learning, http://introtodeeplearning.com • Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016, http://www.deeplearningbook.org	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Advanced Machine Learning** (Lecture)	

Module 03-INF-MA-IMAP-DMI: Aufbau Praktische Informatik (DMI)

Aufbau Praktische Informatik (DMI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	none

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire a research-oriented basic understanding of a sub-area of theoretical, practical or applied computer science in the field of Digital Media and Interaction. They understand (architecture) concepts, modeling procedures and/or algorithms and thus the specific methods for developing software in varying domains and can apply these to tasks in the respective sub-domain. The skills acquired are a prerequisite for in-depth modules in the respective sub-area. The specific skills depend on the courses chosen.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module (if not already taken in another module). Courses currently on offer:

- 03-IMAP-ACG Advanced Computer Graphics
- 03-IMAP-D3BV Deep-Learning- und 3D-Bildverarbeitung
- 03-IMAP-VRSIM Virtual Reality and Physically-Based Simulation

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imap-dmi

(The offered courses will be updated depending on available personnel)

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Englisch / German (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Aufbau Praktische Informatik (DMI)	
Frequency: each semester	**Language(s) of instruction:** Englisch / German (Neben englischsprachigen Wahlalternativen kann es auch deutschsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Virtual Reality and Physically-Based Simulation** (Lecture)	

Module 03-INF-MA-IMAP-SQ: Aufbau Praktische Informatik (SQ)

Aufbau Praktische Informatik (SQ)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	none

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire a research-oriented basic understanding of a sub-area of theoretical, practical or applied computer science in the field of Information Security and/or Software Quality. They understand (architecture) concepts, modeling procedures and/or algorithms and thus the specific methods for developing software in varying domains and can apply these to tasks in the respective sub-domain. The skills acquired are a prerequisite for in-depth modules in the respective sub-area. The specific skills depend on the courses chosen.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module (if not already taken in another module). Courses currently on offer:

- 03-IMAP-ISPS Informationssicherheit - Prozesse und Systeme
- 03-IMAP-SWRE Software-Reengineering
- 03-IMAP-QSE Qualitätsorientierter Systementwurf
- 03-IMAP-TSS Test von Schaltungen und Systemen
- 03-IMAP-TA Testautomatisierung

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imap-sq

(The offered courses will be updated depending on available personnel)

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

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: Deutsch / English (Je nach gewählter Lehrveranstaltung)	
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Aufbau Praktische Informatik (SQ)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Neben deutschsprachigen Wahlalternativen kann es auch englischsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Testautomatisierung** ()	

Module 03-INF-MA-IMAP-VMC: Aufbau Praktische Informatik (VMC)
Aufbau Praktische Informatik (VMC)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	none

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire a research-oriented basic understanding of a sub-area of theoretical, practical or applied computer science in the field of Visual Computing and/or Medical Computing. They understand (architecture) concepts, modeling procedures and/or algorithms and thus the specific methods for developing software in varying domains and can apply these to tasks in the respective sub-domain. The skills acquired are a prerequisite for in-depth modules in the respective sub-area. The specific skills depend on the courses chosen.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module (if not already taken in another module). Courses currently on offer:

- 03-IMAP-ACG Advanced Computer Graphics
- 03-IMAP-MBV Medizinische Bildverarbeitung
- 03-IMAP-VRSIM Virtual Reality and Physically-Based Simulation

Short descriptions of the courses can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imap-vmc

(The offered courses will be updated depending on available personnel)

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

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: Deutsch / English (Je nach gewählter Lehrveranstaltung)	
Description: Je nach gewählter Lehrveranstaltung: Portfolio, Fachgespräch, mündliche Prüfung, Klausur, Hausarbeit, Referat+Ausarbeitung, ggf. Bonusprüfung	

Module courses

Course: Aufbau Praktische Infromatik (VMC)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Es gibt sowohl deutschsprachige als auch englischsprachige Wahlalternativen)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: Abhängig von der gewählten Lehrveranstaltung	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Virtual Reality and Physically-Based Simulation** (Lecture)	

Module 03-INF-MA-IMVA-AI: Vertiefung Angewandte Informatik (AI)

Vertiefung Angewandte Informatik (AI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of applied computer science within the field of Artificial Intelligence. These can include an introduction to specialized subject areas of applied computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Applied Computer Science (03-IMAA-xx) in the field of Artificial Intelligence
- Advanced courses in Applied Computer Science (03-IMVA-xx) in the field of Artificial Intelligence

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the AI specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-ai

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Andreas Breiter
Frequency:	**Duration:**
(depending on capacity) winter or summer semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch / German (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Angewandte Informatik (AI)	
Frequency: (depending on capacity) winter or summer semester	**Language(s) of instruction:** Englisch / German (Es kann sowohl englischsprachige als auch deutschhsprachige Wahlalternativen geben.)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Good Practice in Machine Learning Research** () **Search Technology for Media & Web** (Lecture)	

Module 03-INF-MA-IMVA-DMI: Vertiefung Angewandte Informatik (DMI)

Vertiefung Angewandte Informatik (DMI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of applied computer science within the field of Digital Media and Interaction. These can include an introduction to specialized subject areas of applied computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Applied Computer Science (03-IMAA-xx) in the field of Digital Media and Interaction
- Advanced courses in Applied Computer Science (03-IMVA-xx) in the field of Digital Media and Interaction

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the DMI specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-dmi

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Andreas Breiter
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch / German (Je nach gewählter Lehrveranstaltung)

Description:
Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Angewandte Informatik (DMI)

Frequency: each semester	**Language(s) of instruction:** Englisch / German (Es gibt sowohl englischsprachige als auch deutschsprachige Wahlalternativen)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung

Associated module courses

IT-Management und Data Science (Lecture)

Search Technology for Media & Web (Lecture)

Module 03-INF-MA-IMVA-SQ: Vertiefung Angewandte Informatik (SQ)

Vertiefung Angewandte Informatik (SQ)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of applied computer science within the field of Information Security and Software Quality. These can include an introduction to specialized subject areas of applied computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Applied Computer Science (03-IMAA-xx) in the field of Information Security and Software Quality
- Advanced courses in Applied Computer Science (03-IMVA-xx) in the field of Information Security and Software Quality

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the SQ specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-sq

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Andreas Breiter
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Deutsch / English (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Angewandte Informatik (SQ)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Neben deutschsprachigen Wahlalternativen kann es auch englischsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Medien- und IT-Recht** ()	

Module 03-INF-MA-IMVA-VMC: Vertiefung Angewandte Informatik (VMC)

Vertiefung Angewandte Informatik (VMC)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of applied computer science within the field of Visual Computing and/or Medical Computing. These can include an introduction to specialized subject areas of applied computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Applied Computer Science (03-IMAA-xx) in the field of Visual Computing and/or Medical Computing
- Advanced courses in Applied Computer Science (03-IMVA-xx) in the field of Visual Computing and/or Medical Computing

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the VMC specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-vmc

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Andreas Breiter
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Deutsch / English (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Angewandte Informatik (VMC)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Es kann sowohl deutschsprachige als auch englischsprachige Wahlalternativen geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung

Module 03-INF-MA-IMVP-AI: Vertiefung Praktische Informatik (AI)

Vertiefung Praktische Informatik (AI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of practical computer science within the field of Artificial Intelligence. These can include an introduction to specialized subject areas of practical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Practical Computer Science (03-IMAP-xx) in the field of Artificial Intelligence
- Advanced courses in Practical Computer Science (03-IMVP-xx) in the field of Artificial Intelligence

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the AI specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-ai

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch / German (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Praktische Informatik (AI)	
Frequency: each semester	**Language(s) of instruction:** Englisch / German (Neben englischsprachigen Wahlalternativen kann es auch deutschsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Codierung und Datenkompression** () **Gehirn-Muster-Erkennung** () **Human Robot Interaction** (Lecture) **Machine Learning for autonomous Robots** (Lecture) **Semantische 3D-Perzeption für robotische Systeme** ()	

Module 03-INF-MA-IMVP-DMI: Vertiefung Praktische Informatik (DMI)

Vertiefung Praktische Informatik (DMI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of practical computer science within the field of Digital Media and Interaction. These can include an introduction to specialized subject areas of practical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch / German (Je nach gewählter Lehrveranstaltung)

Description:
Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Praktische Informatik (DMI)	
Frequency: each semester	**Language(s) of instruction:** Englisch / German (Es gibt sowohl deutschsprachige als auch englischsprachige Wahlalternativen)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Rechnernetze - Media Networking** ()	

Module 03-INF-MA-IMVP-SQ: Vertiefung Praktische Informatik (SQ)

Vertiefung Praktische Informatik (SQ)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of practical computer science within the field of Information Security and Software Quality. These can include an introduction to specialized subject areas of practical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Practical Computer Science (03-IMAP-xx) in the field of Information Security and Software Quality
- Advanced courses in Practical Computer Science (03-IMVP-xx) in the field of Information Security and Software Quality

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the SQ specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-sq

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Deutsch / English (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Praktische Informatik (SQ)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Neben deutschsprachigen Wahlalternativen kann es auch englischsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Digital Logic Synthesis** () **Programmsynthese** (Lecture) **Rechnernetze - Media Networking** ()	

Module 03-INF-MA-IMVP-VMC: Vertiefung Praktische Informatik (VMC)

Vertiefung Praktische Informatik (VMC)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of practical computer science within the field of Visual Computing and/or Medical Computing. These can include an introduction to specialized subject areas of practical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Practical Computer Science (03-IMAP-xx) in the field of Visual Computing and/or Medical Computing
- Advanced courses in Practical Computer Science (03-IMVP-xx) in the field of Visual Computing and/or Medical Computing

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the VMC specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-vmc

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Ute Bormann
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch / English (Je nach gewählter Lehrveranstaltung)

Description:
Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Praktische Informatik (VMC)

Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Es gibt sowohl deutschsprachige als auch englischsprachige Wahlalternativen)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung

Associated module courses

Codierung und Datenkompression ()

Rechnernetze - Media Networking ()

Semantische 3D-Perzeption für robotische Systeme ()

Software-Reengineering (Lecture)

Systeme hoher Sicherheit und Qualität (Lecture)

Module 03-INF-MA-IMVT-AI: Vertiefung Theoretische Informatik (AI)

Vertiefung Theoretische Informatik (AI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of theoretical computer science within the field of Artificial Intelligence. These can include an introduction to specialized subject areas of theoretical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Theoretical Computer Science (03-IMAT-xx) in the field of Artificial Intelligence
- Advanced courses in Theoretical Computer Science (03-IMVT-xx) in the field of Artificial Intelligence

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the AI specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-ai

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Sebastian Siebertz
Frequency:	**Duration:**
(depending on capacity) winter or summer semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch / German (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Theoretische Informatik (AI)	
Frequency: (depending on capacity) winter or summer semester	**Language(s) of instruction:** Englisch / German (Es kann sowohl englischsprachige als auch deutschsprachige Wahlalternativen geben.)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Formale Sprachen: Graphtransformation** () **Theorie der Sensorfusion** ()	

Module 03-INF-MA-IMVT-DMI: Vertiefung Theoretische Informatik (DMI)

Vertiefung Theoretische Informatik (DMI)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of theoretical computer science within the field of Digital Media and Interaction. These can include an introduction to specialized subject areas of theoretical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Theoretical Computer Science (03-IMAT-xx) in the field of Digital Media and Interaction
- Advamced courses in Theoretical Computer Science (03-IMVT-xx) in the field of Digital Media and Interaction

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the DMI specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-dmi

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Sebastian Siebertz
Frequency:	**Duration:**
(depending on capacity) winter or summer semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Englisch / German (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Theoretische Informatik (DMI)	
Frequency: (depending on capacity) winter or summer semester	**Language(s) of instruction:** Englisch / German (Es kann sowohl englischsprachige als auch deutschsprachige Wahlalternativen geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung

Module 03-INF-MA-IMVT-SQ: Vertiefung Theoretische Informatik (SQ)

Vertiefung Theoretische Informatik (SQ)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of theoretical computer science within the field of Information Security and Software Quality. These can include an introduction to specialized subject areas of theoretical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Theoretical Computer Science (03-IMAT-xx) in the field of Information Security and Software Quality
- Advanced courses in Theoretical Computer Science (03-IMVT-xx) in the field of Information Security and Software Quality

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the SQ specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-sq

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Sebastian Siebertz
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Deutsch / English (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Theoretische Informatik (SQ)	
Frequency: each semester	**Language(s) of instruction:** Deutsch / English (Neben deutschsprachigen Wahlalternativen kann es auch englischsprachige Angebote geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung

Associated module courses

Formale Sprachen: Graphtransformation ()

Hybrid Systems: Verification and Synthesis (Lecture)

Introduction to Reversible and Quantum Computing (Lecture)

Set Theory and Model Theory (Lecture)

Sparsity - Graphs and algorithms (Lecture)

Module 03-INF-MA-IMVT-VMC: Vertiefung Theoretische Informatik (VMC)

Vertiefung Theoretische Informatik (VMC)

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Computer Science	The prerequisite knowledge is dependent on the chosen course.

Learning content:
The content is dependent on the chosen course and, as such, can not be generalized.

Learning outcomes / competencies / targeted competencies:
Students acquire further skills in the area of theoretical computer science within the field of Visual Computing and/or Medical Computing. These can include an introduction to specialized subject areas of theoretical computer science as well as the development in-depth skills. The specific skills depend on the chosen course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes
Selection of one of the courses offered in this module. The students can select a course from the following list (if not already taken in another module):

- Intermediate Level courses in Theoretical Computer Science (03-IMAT-xx) in the field of Visual Computing and/or Medical Computing
- Advanced courses in Theoretical Computer Science (03-IMVT-xx) in the field of Visual Computing and/or Medical Computing

The course catalog shows which specialization(s) have been assigned to each of the courses offered.

Short descriptions of courses assigned to the VMC specialization can be found at:

https://lvb.informatik.uni-bremen.de/imsp/imv-vmc

Language(s) of instruction:	**Responsible for the module:**
German / English	Prof. Dr. Sebastian Siebertz
Frequency:	**Duration:**
(depending on capacity) winter or summer semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 23/24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination: module exam	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Deutsch / English (Je nach gewählter Lehrveranstaltung)
Description: Will be decided upon by the Lecturer of the chosen course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Vertiefung Theoretische Informatik (VMC)	
Frequency: (depending on capacity) winter or summer semester	**Language(s) of instruction:** Deutsch / English (Es kann sowohl deutschsprachige als auch englischsprachige Wahlalternativen geben)
Contact hours: 4,00	**University teacher:** Lehrende der Informatik
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Theorie der Sensorfusion** ()	

Module 01-ET-BA-GMM: Grundlagen der Mikrosystemtechnik und Mikroelektronik
Introduction to Microsystems and Microelectronics

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Sensors and Electronics • Technical Application Subject / Electrical Engineering / Smart Electronic Systems	none

Learning content:

Mikroelektronik

- Einführung in die Mikroelektronik (Aufbau und Einsatzgebiete mikroelektronischer Schaltungen, Systems-on-Chip und Entwurfsmethoden)
- Entwurfsmethodik: Von Matlab zu Hardware Architekturen
- Prinzipien analoger integrierter Schaltungen, Digitale Schaltungen
- Implementierung dedizierter Hardware-Architekturen: Datenpfad und Kontrollfluss
- Arithmetische Einheiten: Parallel-Prefix-Architekturen
- Einführung in die Architektur von Prozessoren
- Entwurfsmethodik analoger Schaltungen
- Integrierte Operationsverstärker
- Analoge Filter
- Datenkonverter (AD-Wandlung)

Mikrosystemtechnik

- Einführung in die Mikrosystemtechnik (Technologie: Reinraumprozesse)
- Reinraum
- Lithografie
- Silizium
- Schichtenabscheidung
- Micromachining-Prozesse
- Sensoraufbau und MOS-Transistoraufbau

Laborübung

- Reinraumprozesse Mikrosystemtechnologie (Übung im Reinraum) und
- Schaltungsblöcke am Beispiel eines Sensorsystems

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben. z.B.

- J. M. Rabaey, A. Chandrakasan, B. Nikolic, Digital Integrated Circuits - A Design Perspective
- G. Borriello, R. Katz, Contemporary Logic Design, Prentice Hall
- S. Franssila, Introduction to Micro Fabrication, 2ndedition, Wiley

Learning outcomes / competencies / targeted competencies:
Mikroelektronik

- Beherrschen der systematischen Konzipierung und der Entwurf eines mikroelektronischen Systems
- Kenntnis wesentlicher Komponenten moderner analoger integrierter Schaltungen
- Zerlegung einer Systemaufgabenstellung in Teilsysteme und Auswahl geeigneter Schaltungen für eine gegebene Spezifikation, Überprüfung des Entwurfs durch Schaltungssimulation
- Erlernen spezieller Fähigkeiten zur Realisierung funktionsspezifischer mikroelektronischer Systeme

Mikrosystemtechnik

- Kenntnis wesentlicher Mikrosystemtechnologie-Prozesse
- Kenntnis des Aufbaus einiger Sensoren in der Mikrosystemtechnik
- Erfahrung mit Reinraum und Reinraumprozessen

Calculation of student workload:
112 h Preparation / follow-up work
74 h Exam preparation
84 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr.-Ing. Michael Vellekoop
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 20/21 / -	9 / 270 hours

Module examinations

Module examination: Grundlagen der Mikrosystemtechnik und Mikroelektronik

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Praktikum Grundlagen der Mikrosystemtechnik und Mikroelektronik

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Portfolio (AT § 8 Abs. 8)	no

Number of graded components / ungraded components / prerequisites of the examination: - / 1 / -
Language(s) of instruction: Deutsch

Module courses

Course: Einführung in die Mikroelektronik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Steffen Paul Prof. Dr.-Ing. Alberto Garcia-Ortiz
Teaching method(s): Lecture Tutorial	**Associated module examination:** Grundlagen der Mikrosystemtechnik und Mikroelektronik

Course: Einführung in die Mikrosystemtechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Michael Vellekoop
Teaching method(s):	**Associated module examination:** Grundlagen der Mikrosystemtechnik und Mikroelektronik
Associated module courses **Einführung in die Mikroelektronik** (Lecture) **Einführung in die Mikrosystemtechnik** (Lecture)	

Course: Praktikum Mikroelektronik und Mikrosystemtechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Michael Vellekoop Prof. Dr.-Ing. Steffen Paul Prof. Dr.-Ing. Alberto Garcia-Ortiz
Teaching method(s): Laboratory class	**Associated module examination:** Praktikum Grundlagen der Mikrosystemtechnik und Mikroelektronik
Associated module courses **Praktikum Mikroelektronik und Mikrosystemtechnik** (Laboratory class)	

Module 01-ET-MA-DDsy: Praktikum Entwurf digitaler Systeme / Laboratory Design of Digital Systems

Laboratory Design of Digital Systems

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Sensors and Electronics • Technical Application Subject / Electrical Engineering / Smart Electronic Systems	Mastering algebraic methods of digital technology, Boolean algebra and circuit reduction methods

Learning content:

- Logic syntheses using the Synopsis-Framework
- Layout syntheses using the Cadence-Framework
- Verification of digital systems
- Design-for-Test
- Design of functional blocks, testing of sub-modules and system integration

A list of references will be provided at the start of the semester.

Learning outcomes / competencies / targeted competencies:

Students

- acquire basic knowldege of methods used in CAD-tools for automated design of digital systems
- learn special skills to realize function-specific digital modules and complex circuits

Calculation of student workload:

34 h Self-study
28 h Preparation / follow-up work
28 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr.-Ing. Alberto Garcia-Ortiz
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	3 / 90 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination:	**The examination is ungraded?**
Portfolio (AT § 8 Abs. 8)	no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Englisch / German
Description: Anzahl Studienleitstungen: 1

Module courses

Course: Praktikum Entwurf digitaler Systeme	
Frequency: summer semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 0,00	**University teacher:** Prof. Dr.-Ing. Alberto Garcia-Ortiz
Literature: Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.	
Teaching method(s): Laboratory class	**Associated module examination:**

Module 01-ET-MA-MiSP: Praktikum Mikrosystemtechnik (Laboratory Microsystems)
Laboratory Microsystems

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Sensors and Electronics • Technical Application Subject / Electrical Engineering / Smart Electronic Systems	none

Learning content:

- Introduction to microtechnology
- Clean room technology, quality standards in clean room, processing
- Fabrication of a sensor in the clean room
- Characterization of the sensor

Group up to 12 students. Short examination of the preparation before the experiment.

Learning outcomes / competencies / targeted competencies:

The students

- know how to conduct in a clean room environment;
- can work with process equipment;
- obtain experience with micro technology;
- can characterize a sensor element.

Calculation of student workload:

28 h SWS / presence time / working hours
20 h Self-study
42 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr.-Ing. Michael Vellekoop
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	3 / 90 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination:	**The examination is ungraded?**
Portfolio (AT § 8 Abs. 8)	no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Englisch / German
Description: Anzahl Studienleistungen: 1

Module courses

Course: Praktikum Mikrosystemtechnik	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch / German
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Michael Vellekoop
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung
Associated module courses **Praktikum Mikrosystemtechnik** (Laboratory class)	

Module 01-ET-MA-SCL: Laboratory Sensor Characterization
Sensor Characterization Laboratory

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Sensors and Electronics • Technical Application Subject / Electrical Engineering / Smart Electronic Systems	Lecture „Sensors and Measurement Systems"

Learning content:
A thermal sensor for infrared radiation (thermopile) is analyzed. The sensor is exposed to different thermal radiation of varying intensity. Sensitivity, time constant and noise are evaluated.

Groups up to 6 students. Short examination of the preparation before the experiment.

Learning outcomes / competencies / targeted competencies:
The students shall get experience in using sensors and analyzing sensor data.

Calculation of student workload:
90 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr.-Ing. Walter Lang
Frequency:	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: SoSe 24 / WiSe 24/25	**Credit points / Workload:** 3 / 90 hours

Module examinations

Module examination: Modulprüfung

Type of examination:

Form of examination:	**The examination is ungraded?**
Portfolio (AT § 8 Abs. 8)	no

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

Language(s) of instruction:
Englisch

Description:
Anzahl Studienleistungen: 1

Module courses

Course: Laboratory Sensor Characterization	
Frequency: (depending on capacity) winter or summer semester	**Language(s) of instruction:** Englisch
Contact hours: 2,00	**University teacher:** Prof. Dr.-Ing. Walter Lang
Teaching method(s): Laboratory class	**Associated module examination:** Modulprüfung
Associated module courses **Praktikum Sensor Characterization** (Laboratory class)	

Module 01-ET-MA-SSc(a): Sensor Science
Sensor Science

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Electrical Engineering / Sensors and Electronics	none

Learning content:

- Conduct a literature search
- Reading of scientific publications in the field of sensors
- Study specific aspects of sensor science through the found literature
- Write a report on the study
- Oral presentation

A list of references will be provided at the start of the semester.

Learning outcomes / competencies / targeted competencies:
Students are able to:

- conduct an efficient literature search,
- discriminate between the main and minor aspects of a research topic,
- study and understand the physical and electronic fundamentals of a specific sensor,
- report in word and in writing.

Calculation of student workload:
56 h Self-study
68 h Exam preparation
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
English	Prof. Dr.-Ing. Michael Vellekoop
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung	
Type of examination:	
Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: - / - / -
Language(s) of instruction: Englisch / German
Description: Anzahl Prüfungsleistungen: 1

Module courses

Course: Sensor Science	
Frequency: winter semester, yearly	**Language(s) of instruction:** Englisch
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Michael Vellekoop
Literature: A list of references will be provided at the start of the semester.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Sensor Science** (Lecture)	

Module 01-ET-MA-ASV(a): Architekturen der digitalen Signalverarbeitung
Architectures for Digital Signal Processing

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Smart Electronic Systems	Grundlagen der Digitaltechnik

Learning content:

- Architectures and implementation techniques for application-specific digital designs
- Digital design flow and performance evaluation
- Design techniques for digital arithmetic: iterative methods, table-based methods, polynomial function approximation
- Novel digital number formats: Unums, SORNs, Posits, etc.

A list of references will be provided at the start of the semester..

Learning outcomes / competencies / targeted competencies:

The students know

- the essentials of application-specific digital design;
- how to evaluate the performance of application-specific digital designs;
- how to use a large set of state-of-the-art implementation techniques for digital arithmetic;
- the advantages of modern digital number formats.

Calculation of student workload:

68 h Exam preparation
56 h SWS / presence time / working hours
56 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English / German	Prof. Dr.-Ing. Steffen Paul
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination:

Form of examination:	The examination is ungraded?
Oral	no

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

- / - / -

Language(s) of instruction: Englisch / German
Description: Anzahl Prüfungsleistungen: 1

Module courses

Course: Architekturen der digitalen Signalverarbeitung	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Steffen Paul
Literature: A list of references will be provided at the start of the semester.	
Teaching method(s): Lecture Tutorial	**Associated module examination:** Modulprüfung

Module 01-ET-MA-CAMC: Circuits and Architectures for Mobile Communication Systems

Circuits and Architectures for Mobile Communication Systems

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Electrical Engineering / Smart Electronic Systems	none

Learning content:

- Systementwurf der Hardware drahtloser Kommunikationssysteme
- Überblick über wichtige Funkstandards
- Algorithmen der drahtlosen Kommunikation
- Prinzipien der Hardwareabbildung
- Wesentliche Hardwaremodule integrierter Kommunikationssysteme
- Programmierbare Architekturen (VLIW, SIMD), ASIP-Entwurf
- HW/SW Aufteilung
- Ausgewählte Implementierungen von wichtigen Empfängeralgorithmen

Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.

Learning outcomes / competencies / targeted competencies:

Die Studierenden kennen:

- wichtige Verfahren der Mobilkommunikation aus der Implementierungsperspektive;
- die Funktion wesentlicher Module des Empfänger- und Senderkette;
- wichtige Algorithmen von Mobilfunksystemen und deren schaltungsmäßige Umsetzung;
- allgemeine Methoden der Abbildung von Algorithmen auf Schaltungen;
- ausgewählte Implementierungsbeispiele.

Calculation of student workload:

56 h SWS / presence time / working hours
68 h Exam preparation
56 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr.-Ing. Steffen Paul
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
SoSe 24 / -	6 / 180 hours

Module examinations

Module examination: Modulprüfung

Type of examination:

Form of examination: Oral	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: - / - / -	
Language(s) of instruction: Deutsch	
Description: Anzahl Prüfungsleistungen: 1	

Module courses

Course: Circuits and Architectures for Mobile Communication Systems	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 4,00	**University teacher:** Prof. Dr.-Ing. Steffen Paul
Literature: Literatur zum Modul wird in den jeweiligen Veranstaltungen bekanntgegeben.	
Teaching method(s):	**Associated module examination:** Modulprüfung
Associated module courses **Circuits and Architectures for Mobile Communication Systems** (Lecture)	

Module 04-PT-MA-M11-BM1-FT / M11-BM1-IM: Basismodul 1 - FT/IM-Fertigungsmesstechnik und Qualitätswissenschaft

Manufacturing Measurement Technology and Quality Science

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Production Engineering / Manufacturing Engineering • Technical Application Subject / Production Engineering / Industrial Management	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:
62 h Preparation / follow-up work
62 h Exam preparation
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr.-Ing. habil. Andreas Fischer
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 13/14 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Laboratory for Geometrical Metrology

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Portfolio (AT § 8 Abs. 8)	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Quality Sciences - Basics

Type of examination: partial 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: Deutsch	

Module courses

Course: Geometrische Messtechnik mit Labor	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • www.aukom.info • A. Weckenmann: Koordinatenmesstechnik, Carl Hanser Verlag, München, 2012 • W. Jorden, W. Schütte, Form- und Lagetoleranzen – Handbuch für Studium und Praxis, Carl Hanser Verlag, München, 2012	
Teaching method(s): Lecture	**Associated module examination:** 1. Prüfungsleistung Geometrische Messtechnik mit Labor
Associated module courses **Geometrische Messtechnik mit Labor** (Lecture)	

Course: Grundlagen der Qualitätswissenschaft	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • R. Schmitt, T. Pfeifer: Qualitätsmanagement – Strategien, Methoden, Techniken, Carl Hanser Verlag, München, 2015 • R. Schmitt, T. Pfeifer: Masing Handbuch Qualitätsmanagement, Carl Hanser Verlag, München, 2014 • W. Kleppmann: Versuchsplanung – Produkte und Prozesse optimieren, Carl Hanser Verlag, München, 2016 • E. Hering, J. Triemel, H.P. Blank: Qualitätsmanagement für Ingenieure, Springer Verlag, Berlin, 2003	

Teaching method(s): Lecture	**Associated module examination:** 2. Prüfungsleistung Grundlagen der Qualitätswissenschaft
Associated module courses **Grundlagen der Qualitätswissenschaft** (Lecture)	

Module 04-PT-MA-M11-BM2-FT: Basismodul 2 - FT - Fertigungstechnik
Manufacturing Technology

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Production Engineering / Manufacturing Engineering	

Learning content:

Learning outcomes / competencies / targeted competencies:

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?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr.-Ing. habil. Prof. h.c. Dr. h.c. Bernhard Karpuschewski
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 13/14 / -	6 / 180 hours

Module examinations

Module examination: Manufacturing Technology

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Written examination	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module courses

Course: Fertigungstechnik

Frequency:	**Language(s) of instruction:**
summer semester, yearly	Deutsch

Contact hours:	**University teacher:**
4,00	

Literature:

• Mitschreibskript mit Folien der Veranstaltung

• Weiterführende Literatur:

• Fritz, A.H., Schulze, G.: Fertigungstechnik, Springer Verlag, 2015

• Lange, K.: Umformtechnik, Springer-Verlag 1988

• Klocke, F.; König, W.: Fertigungsverfahren 1 – Drehen, Fräsen, Bohren, Springer Verlag, 2008

• Klocke, F.; König, W.: Fertigungsverfahren 2 – Schleifen, Honen, Läppen, Springer Verlag, 2005

• Tschätsch, H.: Praxis der Umformtechnik: Arbeitsverfahren, Maschinen, Werkzeuge, Springer Fachmedien, 2005

• Tönshoff, H. K.; Denkena, B.: Spanen, Springer, 2011

• Grote, K.H.; Feldhusen, J.: Dubbel: Taschenbuch für den Maschinenbau, Springer Vieweg, 2014

• Minke, E.: Handbuch zur Abrichttechnik, Riegger Diamantwerkzeuge, 1999

• Spur, G.; Stöferle, T.: Handbuch der Fertigungstechnik, Band 1/3 – Spanen, Carl Hanser, 2014

• Spur, G.; Stöferle, T: Handbuch der Fertigungstechnik, Band 2/3 – Umformen und Zerteilen, Carl Hanser, 2012

Teaching method(s):	**Associated module examination:**
Lecture	Modulprüfung Fertigungstechnik

Module 04-PT-MA-M11-BM1-MW: Basismodul 1 - MW – Werkstofftechnik - Metalle
Material Science - Metals

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Production Engineering / Materials Sciences	

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:
68 h Exam preparation
56 h SWS / presence time / working hours
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Prof. Dr.-Ing. habil. Rainer Fechte-Heinen
Frequency: summer semester, yearly	**Duration:** 2 semester[s]
The module is valid since / The module is valid until: SoSe 24 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Lightweight Materials I

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Oral examination (single)	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Material Science 3 - Metals

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Oral examination (single)	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module courses

Course: Werkstoffe des Leichtbaus 1	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • Callister, Rethwisch: Materialwissenschaften und Werkstofftechnik, Wiley-VCh, Weinheim • Bargel, Schulze: Werkstoffkunde, Springer, Heidelberg • Macherauch, Zoch: Praktikum in Werkstoffkunde, Vieweg+Teubner, Wiesbaden • Ashby: Materials Selection in Mechanical Design, Butterworth-Heinemann, Oxford • Klein: Leichtbau-Konstruktion, Vieweg, Braunschweig • Gottstein: Physical foundations of materials, Springer-Verlag Berlin Heidelberg	
Teaching method(s): Lecture	**Associated module examination:** 1. Prüfungsleistung Werkstoffe des Leichtbaus 1
Associated module courses **Werkstoffe des Leichtbaus 1** (Lecture)	

Course: Werkstofftechnik 3 - Metalle	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • Callister, Rethwisch: Materialwissenschaften und Werkstofftechnik, Wiley-VCh, Weinheim • Bargel, Schulze: Werkstoffkunde, Springer, Heidelberg • Macherauch, Zoch: Praktikum in Werkstoffkunde, Vieweg+Teubner, Wiesbaden • Ashby: Materials Selection in Mechanical Design, Butterworth-Heinemann, Oxford • Klein: Leichtbau-Konstruktion, Vieweg, Braunschweig • Gottstein: Physical foundations of materials, Springer-Verlag Berlin Heidelberg	
Teaching method(s): Lecture	**Associated module examination:** 2. Prüfungsleistung Werkstofftechnik 3 - Metalle

Module 04-PT-MA-M11-BM2-MW: Basismodul 2 - MW – Werkstofftechnik - Polymere und Fasern

Material Science - Polymers and Fibres

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Production Engineering / Materials Sciences	

Learning content:

Learning outcomes / competencies / targeted competencies:

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?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr. rer. nat. Bernd Mayer
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 13/14 / -	6 / 180 hours

Module examinations

Module examination: Properties, Production and Applications of Fibres

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch / English

Module examination: Material Science - Polymers

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch / English

Module courses

Course: Fasern: Eigenschaften, Herstellung, Anwendungen

Frequency:	**Language(s) of instruction:**
winter semester, yearly	Deutsch
Contact hours:	**University teacher:**
2,00	

Literature:
• Domininghaus, Elsner, Eyerer, Hirth: Kunststoffe, Springer, Heidelberg

• Menges, Haberstroh, Michaeli, Schmachtenberg: Menges Werkstoffkunde Kunststoffe, Hanser, München

• Herrmann: Script zur Vorlesung

Teaching method(s):	**Associated module examination:**
Lecture	1. Prüfungsleistung Fasern: Eigenschaften, Herstellung, Anwendungen

Associated module courses

Fasern: Eigenschaften, Herstellung, Anwendungen (Lecture)

Course: Werkstofftechnik - Polymere

Frequency:	**Language(s) of instruction:**
winter semester, yearly	Deutsch
Contact hours:	**University teacher:**
2,00	

Literature:
• Domininghaus, Elsner, Eyerer, Hirth: Kunststoffe, Springer, Heidelberg

• Menges, Haberstroh, Michaeli, Schmachtenberg: Menges Werkstoffkunde Kunststoffe, Hanser, München

• Herrmann: Script zur Vorlesung

Teaching method(s):	**Associated module examination:**
Lecture	2. Prüfungsleistung Werkstofftechnik - Polymere

Associated module courses

Werkstofftechnik - Polymere (Lecture)

Module 04-PT-MA-M11-BM1-VT: Basismodul 1 - VT – Stoffübertragung
Mass Transfer

Assignment to areas of study:	Content-related prior knowledge or skills:
• Technical Application Subject / Production Engineering / Process Engineering	none

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:
68 h Exam preparation
56 h SWS / presence time / working hours
56 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
German	Dipl-Ing. Ulrich Peter Mießner
Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 13/14 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Mass Transfer I

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Mass Transfer II

Type of examination: partial exam

Form of examination:	The examination is ungraded?
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module courses

Course: Stoffübertragung I	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • Dreyer, M.: Stoffübertragung I, Skript zur Vorlesung, U Bremen • Dreyer, M.: Stoffübertragung II, Skript zur Vorlesung, U Bremen • Brauer, H., Stoffaustausch einschliesslich chemischer Reaktionen, Verlag Sauerländer, Aarau und Frankfurt am Main 1971 • Baehr, H., Stephan, K.: Wärme- und Stoffübertragung, 7. Auflage., Springer Verlag, Berlin 2010 • Fritsching, U.: Skript zur Vorlesung MPS, Univ. Bremen	
Teaching method(s): Lecture	**Associated module examination:** 1. Prüfungsleistung Stoffübertragung I
Associated module courses **Stoffübertragung I** (Lecture)	

Course: Stoffübertragung II	
Frequency: winter semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**
Literature: • Dreyer, M.: Stoffübertragung I, Skript zur Vorlesung, U Bremen • Dreyer, M.: Stoffübertragung II, Skript zur Vorlesung, U Bremen • Brauer, H., Stoffaustausch einschliesslich chemischer Reaktionen, Verlag Sauerländer, Aarau und Frankfurt am Main 1971 • Baehr, H., Stephan, K.: Wärme- und Stoffübertragung, 7. Auflage., Springer Verlag, Berlin 2010 • Fritsching, U.: Skript zur Vorlesung MPS, Univ. Bremen	
Teaching method(s): Lecture	**Associated module examination:** 2. Prüfungsleistung Stoffübertragung II
Associated module courses **Stoffübertragung II** (Lecture)	

Module 04-PT-MA-M11-BM2-VT: Basismodul 2 - VT – Thermische und chemische Verfahrenstechnik
Thermal and Chemical Process Engineering

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Technical Application Subject / Production Engineering / Process Engineering	

Learning content:

Learning outcomes / competencies / targeted competencies:

Calculation of student workload:
84 h SWS / presence time / working hours
48 h Exam preparation
48 h Preparation / follow-up work

Are there optional courses in the modules?
no

Language(s) of instruction:	**Responsible for the module:**
German	Prof. Dr.-Ing. Johannes Kiefer
Frequency:	**Duration:**
summer semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 13/14 / -	6 / 180 hours

Module examinations

Module examination: Solution Thermodynamics

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Deutsch

Module examination: Reaction Technology I

Type of examination: partial exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -
Language(s) of instruction: Deutsch

Module courses

Course: Thermodynamik der Gemische	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 4,00	**University teacher:**

Literature:

• Vorlesungsskripte

• H.D. Baehr, S. Kabelac: Thermodynamik, Springer Verlag

• C. Lüdecke, D. Lüdecke: Thermodynamik, Springer Verlag

• K. Stephan, F. Mayinger, K. Schaber, P. Stephan: Thermodynamik, Band 2: Mehrstoffsysteme + Chem. Reaktionen, Springer Verlag

• G. Emig, E. Klemm: Technische Chemie, Springer Verlag

• M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken: Technische Chemie, Wiley-VCH

• O. Levenspiel: Chemical Reaction Engineering, John Wiley

• K.J. Laidler: Chemical Kinetics, Harper & Row

Teaching method(s): Lecture Tutorial	**Associated module examination:** 1. Prüfungsleistung Thermodynamik der Gemische

Course: Technische Reaktionsführung 1	
Frequency: summer semester, yearly	**Language(s) of instruction:** Deutsch
Contact hours: 2,00	**University teacher:**

Literature:

• Vorlesungsskripte

• H.D. Baehr, S. Kabelac: Thermodynamik, Springer Verlag

• C. Lüdecke, D. Lüdecke: Thermodynamik, Springer Verlag

• K. Stephan, F. Mayinger, K. Schaber, P. Stephan: Thermodynamik, Band 2: Mehrstoffsysteme + Chem. Reaktionen, Springer Verlag

• G. Emig, E. Klemm: Technische Chemie, Springer Verlag

• M. Baerns, A. Behr, A. Brehm, J. Gmehling, H. Hofmann, U. Onken, A. Renken: Technische Chemie, Wiley-VCH

• O. Levenspiel: Chemical Reaction Engineering, John Wiley

• K.J. Laidler: Chemical Kinetics, Harper & Row

Teaching method(s):	**Associated module examination:**
Lecture	2. Prüfungsleistung Technische Reaktionsführung 1