ENVIRONMENTAL CAMPUS BIRKENFELD

sustainable. innovative. digital.

Course Catalogue

Environment and Technology

1- Core modules of the Environment and Technology Study Exchange Program

These courses form the core modules of the respective study exchange program. The total amount of ECTS chosen depends on the specifications of your sending institution and will be specified through your Learning Agreement.

Winter semester

1-1	**Principles of Engineering II**	[module code: PRINCENG II]	[5 ECTS]
1-2	**Information Technology**	[module code: INFORTEC]	[5 ECTS]
1-3	**German Foreign Language**	[module code: GFL]	[5 ECTS]
1-4	**Specialized Project Work**	[module code: FP]	[5 ECTS]
1-5	**Interdisciplinary Project**	[module code: INTERPRO]	[5 ECTS]
1-6	***Environmental Monitoring**	[module code: UMON]	[5 ECTS]
1-7	***Energy Informatics**	[module code: ENINF]	[5 ECTS]
1-8	***Remote Sensing**	[module code: REMSEN]	[5 ECTS]

Summer semester

1-9	**Principles of Engineering I**	[module code: PRINCENG I]	[5 ECTS]
1-10	**Chemistry and Ecology**	[module code: CHECO]	[5 ECTS]
1-11	**Solar Energy**	[module code: SOLAR]	[5 ECTS]
1-12	**Sustainable Energy Systems**	[module code: SUENSY]	[5 ECTS]
1-13	**Manufacturing Technology**	[module code: MANUTEC]	[5 ECTS]
1-14	**German Foreign Language**	[module code: GFL]	[5 ECTS]
1-15	**Specialized Project Work**	[module code: FP]	[5 ECTS]
1-16	**Interdisciplinary Project**	[module code: INTERPRO]	[5 ECTS]
1-17	***Geoengineering**	[module code: GEOENG]	[5 ECTS]

*These modules are offered depending on the capacities of the respective semester. You can choose the courses within your Learning Agreement. If your chosen module is not offered during the exchange semester you will be contacted to discuss other options.

2- Additional selectable Modules

The courses listed below can be chosen additionally to the core modules of your program. The total amount of ECTS chosen depends on the specifications of your sending institution and will be specified through your Learning Agreement.

Winter semester

2-1	**Physics**	[module code: PHYENG]	[5 ECTS]
2-2	**Mathematics I**	[module code: MATHENG I]	[5 ECTS]
2-3	**Applied Biotechnology**	[module code: APPBIO]	[5 ECTS]
2-4	***Recent Topics on Internet of Things**	[module code: RTID]	[5 ECTS]

Summer semester

2-5	**Thermodynamics**	[module code: THERMO]	[5 ECTS]
2-6	**Lab Work**	[module code: LAWO]	[5 ECTS]
2-7	**Finite Element Analysis**	[module code: FINELE I]	[5 ECTS]
2-8	**Applied Biotechnology**	[module code: APPBIO]	[5 ECTS]
2-9	***Recent Topics on Internet of Things**	[module code: RTID]	[5 ECTS]
2-10	***Programming in Java**	[module code: PROJA]	[5 ECTS]

*These modules are offered depending on the capacities of the respective semester. You can choose the courses within your Learning Agreement. If your chosen module is not offered during the exchange semester you will be contacted to discuss other options.

3- Annex

On the following pages you will find detailed module descriptions and further information on the following modules:

- **Applied Biotechnology**
- **Chemistry and Ecology**
- **Energy Informatics***
- **Environmental Monitoring***
- **Finite Element Analysis**
- **Geoengineering***
- **German Foreign Language**
- **Information Technology**
- **Interdisciplinary Project**
- **Lab Work**
- **Manufacturing Technology**
- **Mathematics I**
- **Physics**
- **Principles of Engineering I**
- **Principles of Engineering II**
- **Programming in Java***
- **Recent Topics on Internet of Things***
- **Remote Sensing***
- **Solar Energy**
- **Specialized Project Module**
- **Sustainable Energy Systems**
- **Thermodynamics**

*These modules are offered depending on the capacities of the respective semester. You can choose the courses within your Learning Agreement. If your chosen module is not offered during the exchange semester you will be contacted to discuss other options.

Applied biotechnology			**5 ECTS**
Module code: ABT	**Workload:** 150 Stunden		**Duration:** 1 Semester
Didactic concept: practical work	**Contact hours:** 4 SWS/ 45 h	**Self-study:** 105 h	**Group size:** 5 Studierende

Applicability of the module:
Part of the Study Exchange Program "Biological, Pharmaceutical and Process Engineering"

Learning goals:
This course enables students to describe the
biochemical, procedural and technological processes involved in mashing, wort boiling, fermentation, storage and maturation in the brewing process. They will have the skills to independently produce a beer according to the German Purity Law using a selected recipe. They are familiar with the analyses and microbiological tests required for beer preparation and the fermentation process. They are familiar with the analyses and microbiological tests required for beer preparation and the fermentation process.

Module Content:
• Brewing and fermentation yeast: structure of the yeast cell, basics of yeast propagation
• Substrate provision: brewing-relevant yeast physiology, flavouring substances, fermentation by-products
• Plant and process technology in brewing and fermentation technology: tank types, measurement and analysis technology
• Yeast management: yeast cultivation, yeast treatment
• Fermentation technology: maturation and storage of beer, process control variants
• Filtration technology: filter materials, auxiliary materials, filtration processes
• Stability: preservation and bottling, product stability criteria, preservation
Beer is produced as part of the practical work.

Recommendations for participation:
none

Requirement for awarding of ECTS points:
Participation in the practical course, presentation and report

Scope and duration of the examination:
General regulations concerning the type and scope as well as the performance and grading of study and examination achievements are defined in the examination regulations of the respective degree programme. The type of proof of achievement as well as precise notes and details will be announced by the respective lecturer at the beginning of the semester.

Frequency:
Every semester

Responsible for module:
Prof. Dr. A. Schweizer

Bibliography:

- Kunze, Wolfgang, Technology Brewing and Malting, 6th Edition (2019), VLB Berlin
- Narziss, Ludwig & Back, Martina, Abriss der Bierbrauerei, 9. Auflage (2017), Wiley-VCH
- Briggs, Dennis E. et al., Brewing: Science and Practice, 1st Edition (2004), Woodhead Publishing

Chemistry and Ecology		
Duration	1 semester	
Study Semester	2nd semester	
Frequency	Winter semester	
Recommended Prerequisites	None	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 45 h	
Self-Study	105 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture	
Responsible for Module	Prof. Dr. Stefan Stoll	
Teaching Personnel	Prof. Dr. Stefan Stoll	
Requirement for Awarding of ECTS Points	Passed module examinations	
Methods of Evaluation	☒ Written exam (100%) ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

The students learn about the functioning of important ecosystems. They have insight in basics of ecosystem theory and understand essential energy and matter cycles and the physico- and biochemical processes on which they are based. They know about the origin, distribution patterns and threat of biodiversity and know options for the protection of biodiversity and ecosystem functions.

2 Module Content and Course Schedule

This module covers basics in ecology and environmental sciences. The following topics will be covered:

- Important terrestrial, freshwater and marine ecosystems
- Ecosystem theory, ecosystem structure and dynamics
- Global carbon, nitrogen, and water cycle, including important physico- and biochemical processes on which they are based
- Global energy budget, climate and weather
- Ecosystem functions and services
- The origins of biodiversity, threats to biodiversity, and measures to protect biodiversity
- Basics in ecotoxicology
- Ecosystem management and restoration

3 Didactic Concept

- Lecture

4 Bibliography

Begon, Harper, Townsend. Ecology: From Individuals to Ecosystems. Blackwell.

Darwin. On the origin of species. Oxford World´s Classics.

Walker, Sibly, Hopkin, Peakall. Principles of Ecotoxicology. Taylor & Francis.

Energy Informatics		
Duration	1 semester	
Study Semester	5th semester	
Frequency	Winter semester	
Recommended Prerequisites	None	
Classification	☐ Required Course ☒ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Seminar, Project Workshop	
Responsible for Module	Prof. Dr. Henrik te Heesen	
Teaching Personnel	Prof. Dr. Henrik te Heesen	
Requirement for Awarding of ECTS Points	Grade and credit points are awarded based on portfolio examination. The portfolio examination consists of tests accompanying the course and a programming project at the end. The tests are smaller programming tasks graded as "pass/fail". At least 75 percent of the tasks must be passed to complete the programming project.	
	The programming project is a task in which the students must apply what they have learned to a problem in the field of energy technology. For this purpose, a program is developed independently, including the programming concepts learned for this purpose.	
Methods of Evaluation	☐ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☒ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

The module is designed to provide students with advanced knowledge of the structure of today's energy systems, as well as a basic understanding of how to translate energy economics tasks into a digital representation.

Upon completion of this module, students will understand the subject matter and a wealth of skills, such as the ability to further develop solutions to energy management problems, effectively communicate results derived from energy models, and capture and parameterize the generation and consumption systems within a given region in digital form. In addition, students will become familiar with implementing power system modeling scripts, applying power system optimization algorithms, and visualizing power systems and energy flows through various means. This hands-on learning approach will equip students with the skills necessary to solve real-world problems in the energy industry.

Recommendation for attendance:

- Basic knowledge of computer science (for example, through a course "Informatics for Engineers" or "Computer Science for Industrial Engineers").
- Basic knowledge of power engineering
- In addition, a basic interest in solving energy engineering problems with the help of IT is required.

2 Module Content and Course Schedule

To be able to model, simulate and optimize energy systems considering volatile, renewable energy sources, the generation and consumption systems in a region must be digitally recorded and parameterized so that, among other things, conclusions can be drawn from this system regarding potential for energy savings as well as forecasts for future development. For this purpose, the students will work on the following points:

- Introduction to basic control structures
- Basics of procedural and object-oriented programming
- Building a database structure
- Programming of scripts for modeling the energy system
- Visualization of energy data
- Coding rules and documentation of source code

The programming content is applied to energy engineering problems. The programming language is Python.

3 Didactic Concept

Seminar with exercises

The concept of the teaching form is "Flipped Classroom": The students acquire the content basics through guided self-study, the attendance time is used for the joint processing of assignments.

4 Bibliography

R. Zahoransky. Power engineering. Springer-Verlag

Educational videos on power engineering

Educational videos and online tutorials for the introduction to Python and databases (SLQ).

Further literature will be announced during the course

Environmental Monitoring		
Duration	1 semester	
Study Semester	5th semester	
Frequency	Winter semester	
Recommended Prere-quisites	None	
Classification	☐ Required Course ☒ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Exercises, Excursions	
Responsible for Module	Prof. Dr. Stefan Stoll	
Teaching Personnel	Prof. Dr. Stefan Stoll	
Requirement for Award-ing of ECTS Points	Passed module examination	
Methods of Evaluation	☒ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

Students learn about the objectives and selected methods of environmental monitor-ing. They will be able to plan and implement monitoring concepts to inform about specific environmental structures and processes, manage monitoring data, perform simple statistical evaluations and present monitoring results adequately.

2 Module Content and Course Schedule

This course teaches the planning and implementation of environmental monitoring measures. The data collected will be documented and subjected to statistical analyses.

Course Schedule

1. Actors and objectives in environmental monitoring

2. Characteristics of physical, chemical and biological measurands
3. Environmental indicators
4. Socio-economic assessments and ecosystem services
5. Development of monitoring concepts
6. Field and laboratory exercises on selected monitoring methods
7. Data and Metadata Management
8. Basic statistical analysis techniques
9. Presentation and communication of monitoring results

3 Didactic Concept

- Lecture and interactive workshop elements
- Integration of web media
- Independent project work and portfolio design

4 Bibliography

Müller et al. (Hrsg.), 2010, Long-Term Ecological Research - Between Theory and Application. Springer-Verlag, Heidelberg.

Meier et al., 2006, Methodisches Handbuch Fließgewässerbewertung (http://www.fliessgewaesserbewertung.de/download/handbuch/).

Haase et al, 2016, The value of long-term ecosystem research (LTER): Addressing global change ecology using site-based data. Ecological Indicators 65 (special issue): 1-160.

Finite Element Analysis			**5 ECTS**
Module code: FINELE I	**Workload:** 150 hours		**Duration:** 1 Semester
Didactic concept: Lecture with integrated practice sessions	**Contact hours:** 4 SWS/ 45 h	**Self-study:** 105 h	**Group size:** 60 students

Applicability of the module:
As compulsory module: PT, D-PT
As compulsory elective module: see compulsory elective module catalogue (homepage under "Info for the current semester")

Learning goals:
After completing the course, students will be able to apply the theoretical foundations of the methods to perform engineering analyses with an FEM program and to critically interpret the results.

Module Content:
In this course, the theory of linear finite element methods (FEM) is presented and applied to specific engineering problems in accompanying exercises.

- Introduction to elasticity theory
- Development of stiffness matrices
- Implementation of boundary conditions
- Solution methods (direct and indirect approaches)
- Shape functions for standard elements
- Convergence analysis and stress evaluation
- Introduction to FEM applications
- Creation and preparation of component geometries
- Material and cross-section properties
- Development of a finite element model
- Supports and loading conditions
- Computation and evaluation
- Import from CAD programs
- By varying calculation parameters, the accuracy and limitations of FEM are demonstrated, and the results are compared with analytical methods.

Recommendations for participation:
Knowledge of mechanics, strength of materials, and computer-aided design (CAD I)

Requirement for awarding of ECTS points:
Grade and credit points are awarded on the basis of laboratory work and an oral examination.

Scope and duration of the examination:
General regulations concerning the type and scope as well as the performance and grading of study and examination achievements are defined in the examination regulations of the respective degree programme. The type of proof of achievement as well as precise notes and details will be announced by the respective lecturer at the beginning of the semester.

Weight of grade (% of credit):
To be indicated for Bachelor's modules:
5/165 (3.03%) for 6-semester programmes;
5/180 (2.78%) for 7-semester programmes;
5/150 (3.3%) for dual study programme D-PT
To be indicated for Master's modules:
5/90 (5.56 %) for 3-semester programmes;
5/120 (4.17%) for 4-semester programmes

Frequency:
Annually (in the summer semester)

Responsible for module:
Prof. Dr. L. Lentz

Bibliography:

- Müller, G. und Groth, C.: FEM für Praktiker, Expert-Verlag
- Knothe, K. und Wessels, H.: Finite Elemente, Springer-Verlag
- Bielak, J.: The Finite Element Method: A Primer, Springer-Verlag

Geoengineering		
Duration	1 semester	
Study Semester	6th semester	
Frequency	Summer semester	
Recommended Prere-quisites	None	
Classification	☐ Required Course ☒ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	Same as credit points	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Seminar	
Responsible for Module	Prof. Dr. Peter Fischer-Stabel	
Teaching Personnel	Prof. Dr. Peter Fischer-Stabel	
Requirement for Award-ing of ECTS Points	Passed module examination	
Methods of Evaluation	☐ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☒ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

In this course, the students will learn the fundamentals of meteorology and climate sciences as well as the basic principles of climate modelling to be able to explain the climate system. Based on this knowledge, the participants will do research work to get an overview regarding the different concepts and technologies, but also the potential and risks of Geo-Engineering. As a general learning goal, after the class, the students will be able to follow the ongoing discussion regarding climate engineering and its effects on an objective science-based level. In addition, they will be able to estimate the effort needed for an implementation and the potential effects by the application of this technologies.

2 Module Content and Course Schedule

The course is structured as follows:

1. Introduction and course overview

Outline of course topics, didactic approach and individual introduction

2. Fundamentals of Meteorology

Brief overview in the meteorology and climate science, definition of terms, fundamentals of meteorological measurement networks

3. The Climate System

Climate zones, factors affecting climate, climate variation, historical aspects, causes of changes, projections

4. Natural Events altering the Climate

Effects of natural events such as Milanokovitch cycles, major volcanic eruptions, solar flares, forest fires etc. to the climate are discussed

5.-9. Concepts of Geo-Engineering I - V

Introduction to different technologies such as carbon capture and storage (CCS), solar radiation management, ocean fertilization, forestry and others

10. Geo-Engineering and Environmental Ethics

Ethical aspects of such technologies are discussed as well as the legal and political framework

11. Final individual Presentation

Presentation of a special topic in the thematic frame of the module

12. Wrap-up and Course summary

3 Didactic Concept

- Seminar format: alternating lecture, seminaristic- and cooperative project phases
- Media-supported presentations
- Course media and handouts available online
- Flexible course concept and adjustment of topics depending on individual student background and input
- Intensive media use and up-to-date example
- Excursions

4 Bibliography

Keith, David, 2001: Geoengineering - *Nature*, **409**, 420.

Further information on recently published online and offline sources is supplied during the course.

German Foreign Language I	GFL I
Duration	1 semester
Study Semester	1st semester
Frequency	Winter semester
Recommended Prerequisites	German: None / Foreign Language: See module description in the appendix.
Classification	☒ Required Course ☐ Compulsory Optional Subject
Credit Points	5
Weight of Grade	2.78 %
Contact Hours	4 SWS / 60 h
Self-Study	90 h
Total Workload	150 h
Course Language	German
Type	Seminar
Responsible for Module	Prof. Dr. Stefan Diemer

Teaching Personnel	Christina Juen, Aloisia Sens and further lecturers	
Requirement for Awarding of ECTS Points	Passed module examinations	
Methods of Evaluation	☒ Written exam (50%) ☒ Oral exam (50%) ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1. Learning Goals German

The course aims to acquire and develop written and oral communication skills and is based on the Common European Framework of Reference for Languages (CEFR). On successful completion of the course, students will have language skills equivalent to level A1 of the CEFR.

2. Module Content and Course Schedule German

The course trains speaking, listening, writing and reading skills with the goal of achieving beginner (A1) language skills.

For a detailed description and a self-assessment grid of CEFR proficiency levels, see https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=090000168045bb52.

3. Didactic Concept German

- Primarily communicative teaching method
- Intensive media use (DVD: video sequences to start each unit, free app for smartphone supports self-study)
- Course media and handouts available online
- Communicative training (tasks and exercises for the basic skills reading, listening, speaking and writing; intercultural communication)

4. Bibliography German

The current list of German as a Foreign Language course books is available at https://www.umwelt-campus.de/en/campus/organisation/fachbereichuwur/sprache-kommunikation/student-info.

German Foreign Language II	GFL II
Duration	1 semester
Study Semester	2nd semester
Frequency	Summer semester
Recommended Prereq-uisites	German Language I / Foreign Language: See module de-scription in the appendix.
Classification	☒ Required Course ☐ Compulsory Optional Subject
Credit Points	5
Weight of Grade	2.78 %
Contact Hours	4 SWS / 60 h
Self-Study	90 h
Total Workload	150 h
Course Language	German
Type	Seminar
Responsible for Module	Prof. Dr. Stefan Diemer

Teaching Personnel	Christina Juen, Aloisia Sens and further lecturers	
Requirement for Awarding of ECTS Points	Passed module examinations	
Methods of Evaluation	☒ Written exam (50%) ☒ Oral exam (50%) ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1. Learning Goals German

The course aims to acquire and develop written and oral communication skills and is based on the Common European Framework of Reference for Languages (CEFR). On successful completion of the course, students will have language skills equivalent to level A2 of the CEFR.

2. Module Content and Course Schedule German

The course trains speaking, listening, writing and reading skills with the goal of achieving elementary (A2) language skills.

For a detailed description and a self-assessment grid of CEFR proficiency levels, see https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=090000168045bb52.

3. Didactic Concept German

- Primarily communicative teaching method
- Intensive media use (DVD: video sequences to start each unit, free app for smartphone supports self-study)
- Course media and handouts available online
- Communicative training (tasks and exercises for the basic skills reading, listening, speaking and writing; intercultural communication)

4. Bibliography German

The current list of German as a Foreign Language course books is available at https://www.umwelt-campus.de/en/campus/organisation/fachbereichuwur/sprache-kommunikation/student-info.

German Foreign Language III	GFL III
Duration	1 semester
Study Semester	3rd semester
Frequency	Winter semester
Recommended Prereq-uisites	German I – II / Foreign Language: See module description in the appendix.
Classification	☒ Required Course ☐ Compulsory Optional Subject
Credit Points	5
Weight of Grade	2.78 %
Contact Hours	4 SWS / 60 h
Self-Study	90 h
Total Workload	150 h
Course Language	German
Type	Seminar
Responsible for Module	Prof. Dr. Stefan Diemer

Teaching Personnel	Christina Juen, Aloisia Sens and further lecturers	
Requirement for Awarding of ECTS Points	Passed module examinations	
Methods of Evaluation	☒ Written exam (50%) ☒ Oral exam (50%) ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1. Learning Goals German

The course aims to acquire and develop written and oral communication skills and is based on the Common European Framework of Reference for Languages (CEFR). On successful completion of the course, students will have language skills equivalent to level B1 of the CEFR.

2. Module Content and Course Schedule German

The course trains speaking, listening, writing and reading skills with the goal of achieving intermediate (B1) language skills.

For a detailed description and a self-assessment grid of CEFR proficiency levels, see https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=090000168045bb52.

3. Didactic Concept German

- Primarily communicative teaching method
- Intensive media use (DVD: video sequences to start each unit, free app for smartphone supports self-study)
- Course media and handouts available online
- Communicative training (tasks and exercises for the basic skills reading, listening, speaking and writing; intercultural communication)

4. Bibliography German

The current list of German as a Foreign Language course books is available at https://www.umwelt-campus.de/en/campus/organisation/fachbereichuwur/sprache-kommunikation/student-info.

German Foreign Language IV	GFL IV
Duration	1 semester
Study Semester	4th semester
Frequency	Summer semester
Recommended Prereq-uisites	German I – III / Foreign Language: See module description in the appendix.
Classification	☒ Required Course ☐ Compulsory Optional Subject
Credit Points	5
Weight of Grade	2.78 %
Contact Hours	4 SWS / 60 h
Self-Study	90 h
Total Workload	150 h
Course Language	German
Type	Seminar
Responsible for Module	Prof. Dr. Stefan Diemer

Teaching Personnel	Christina Juen, Aloisia Sens and further lecturers	
Requirement for Awarding of ECTS Points	Passed module examination(s)	
Methods of Evaluation	☒ Written exam (50%) ☒ Oral exam (50%) ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1. Learning Goals German

The course aims to acquire and develop written and oral communication skills and is based on the Common European Framework of Reference for Languages (CEFR). On successful completion of the course, students will have language skills equivalent to level B2 of the CEFR.

2. Module Content and Course Schedule German

The course trains speaking, listening, writing and reading skills with the goal of achieving upper intermediate (B2) language skills.

For a detailed description and a self-assessment grid of CEFR proficiency levels, see https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=090000168045bb52.

3. Didactic Concept German

- Primarily communicative teaching method
- Intensive media use (DVD: video sequences to start each unit, free app for smartphone supports self-study), German news sequences, songs, etc.)
- Course media and handouts available online
- Communicative training (reading, listening, speaking and writing; intercultural communication)

4. Bibliography German

The current list of German as a Foreign Language course books is available at https://www.umwelt-campus.de/en/campus/organisation/fachbereichuwur/sprache-kommunikation/student-info.

German Foreign Language V	GFL V
Duration	1 semester
Study Semester	5th semester
Frequency	Winter semester
Recommended Prereq-uisites	German Language I – IV / Foreign Language: See module description in the appendix.
Classification	☒ Required Course ☐ Compulsory Optional Subject
Credit Points	5
Weight of Grade	2.78 %
Contact Hours	4 SWS / 60 h
Self-Study	90 h
Total Workload	150 h
Course Language	German
Type	Seminar
Responsible for Module	Prof. Dr. Stefan Diemer

Teaching Personnel	Christina Juen, Aloisia Sens and further lecturers	
Requirement for Awarding of ECTS Points	Passed module examinations	
Methods of Evaluation	☒ Written exam (50%) ☒ Oral exam (50%) ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1. Learning Goals

The course is aimed at acquiring and developing written and oral communication skills and is guided by the requirements of the Common European Framework of Reference for Languages (CEFR). After passing this course successfully, participants with passing grade 4,0 to 2,3 will have language skills according to level B2 CEFR, participants with passing grade 2,0 to 1,0 will have language skills according to level C1 CEFR.

2. Module Content and Course Schedule

The course trains speaking, listening, writing and reading skills with the goal achieving at least upper intermediate (B2) and at best effective operational proficiency (C1) language skills.

For a detailed description and a self-assessment grid of CEFR proficiency levels, see https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=090000168045bb52.

3. Didactic Concept

- Primarily communicative teaching method
- Intensive media use (DVD: video sequences to start each unit, free app for smartphone supports self-study), German news sequences, texts from German newspapers on the environment/sustainability) etc.)
- Course media and handouts available online
- Communicative training (reading, listening, speaking and writing; intercultural communication)

4. Bibliography

The current list of German as a Foreign Language course books is available at https://www.umwelt-campus.de/campus/organisation/fachbereichuwur/sprache-kommunikation/student-info/.

Information Technology		INFORTECH
Duration	1 semester	
Study Semester	3rd semester	
Frequency	Winter semester	
Recommended Prerequisites	None	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Tutorial	
Responsible for Module	Prof. Dr. Guido Dartmann, Prof. Dr. Peter Fischer-Stabel	
Teaching Personnel	Prof. Dr. Guido Dartmann, Prof. Dr. Peter Fischer-Stabel	
Requirement for Awarding of ECTS Points	Passed module examination	
Methods of Evaluation	☒ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

The students will learn methods and tools computer science. They will be able to develop simple algorithms, optimize processes, and compare different approaches. The goal is to develop competences to solve a typical problem of computer engineering.

2 Module Content and Course Schedule

Based on the fundamentals of computer science, a structured way of thinking and program development will be conveyed.

- Computer architecture and system software
- Algorithms (pseudo code, flow diagrams)
- Programming tools and languages

- Data types and expressions (program languages, especially Matlab)
- Modularization (procedures, functions, local variables, recursion)
- Computer Networts & Internet
- Security in IT-Applications
- Green IT

3 Didactic Concept

- Lecture
- Exercises

4 Bibliography

P. Fischer-Stabel, K. Gollmer (2016): Informatik für Ingenieure. Fit für das Internet der Dinge.- utb 4645, UKV/Lucius, München

Interdisciplinary Project	INTERPRO
Duration	1 semester
Study Semester	5th semester
Frequency	Winter semester
Recommended Prere-quisites	Scientific Methods and Concepts
Classification	☒ Required Course ☐ Compulsory Optional Subject
Credit Points	10 (5+5)
Weight of Grade	5.56% (2.78% + 2.78%)
Contact Hours	8 SWS / 120 h (4 SWS / 60 h + 4 SWS / 60 h)
Self-Study	180 h (90 h + 90 h)
Total Workload	300 h (150 h + 150 h)
Course Language	English
Type	Project
Responsible for Module	Current Program Coordinator
Teaching Personnel	Lecturers according the selected topics
Requirement for Award-ing of ECTS Points	Passed module examination according the selected semi-nar
Methods of Evaluation (depends on course structure to be defined by lecturer)	Methods of Evaluation according the selected seminar

1 Learning Goals

The student knows the different practice-oriented and/or theory-oriented techniques and methods for the independent and systematic implementation of research and development tasks. The student is able to handle problems widely autonomously by applying scientific methods and abilities. Another important qualification goal is the ability to work constructively and under pressure within a team.

2 Module Content and Course Schedule

The module is usually carried out through two projects, each carrying 5 ECTS. It is also possible to group this module into a large project with a scope of 10 ECTS. It is welcomed when the module is realized in the form of teamwork, but individual work is

also possible. The specific time and content must be clarified bilaterally with the supervising professor. In principle, it is also possible to complete the module in several semesters.

The module should impart scientific methodology and abilities under the guidance of a professor. A more complex and interdisciplinary work with relation to the degree course will be accomplished. Application-oriented problems will be worked on under supervision in such a way that the student is able to learn generic techniques and methods which are needed for a later independent implementation of research and development works. There is the possibility to work on a project with external partners from institutes, universities or industry. The module may also be covered by the technical projects ("Fachprojekt" and "Interdisziplinäres Projekt") practiced regularly in Department UP/UT faculty, as well as in cooperation with students of other programs.

3 Didactic Concept

- Group Work
- Project Work

4 Bibliography

According the selected topics.

Lab Work		LABO
Duration	1 semester	
Study Semester	4th semester	
Frequency	Summer semester	
Recommended Prerequisites	Physics, Chemistry and Ecology, Principles of Engineering 1, Thermodynamics	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Laboratory practicals	
Responsible for Module	Prof. Dr. Stefan Stoll	
Teaching Personnel	Prof. Dr. Stefan Stoll and further lecturers for specific labs	
Requirement for Awarding of ECTS Points	Passed module examinations	
Methods of Evaluation	☐ Written exam ☐ Oral exam ☒ Laboratory performance (60%) ☐ Project presentation	☐ Portfolio ☒ Term paper or essay (40%) ☐ Practical exam ☐ Colloquium

1 Learning Goals

Students have gained knowledge in experimental design, formulation of scientific hypotheses, execution of scientific experiments and test series and documentation of data and results.

Students have the capacity to present and discuss and contextualize scientific results.

They have acquired the fundamentals of a good laboratory practice including laboratory safety.

Students can differentiate between scientific and unscientific approaches to gain knowledge.

2 Module Content and Course Schedule

On completion of this module students will have:

Undertaken advanced experimental laboratory work, with due attention to laboratory safety;

Manipulated advanced apparatuses;

Recorded and documented scientific data;

Analyzed scientific data to test scientific hypotheses;

Practiced their ability to write clear, scientific reports;

Developed their practical and problem-solving skills.

Students will choose four experiments of interest from a semester catalogue of experiments.

3 Didactic Concept

- Lecture
- Lab practicals

4 Bibliography

Turabian, K.L. (2018) A manual for writers of research papers, theses, and dissertations. 9th ed. The University of Chicago Press. USA.

Manufacturing Technology		MANUTEC
Duration	1 semester	
Study Semester	4th semester	
Frequency	Summer semester	
Recommended Prerequisites	Principles of Engineering I	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Excursions	
Responsible for Module	Prof. Dr.-Ing. Peter Gutheil	
Teaching Personnel	Prof. Dr.-Ing. Peter Gutheil and further lecturers with specific topics	
Requirement for Awarding of ECTS Points	Passed module examination	
Methods of Evaluation	☒ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

The goal of the lecture is to acquire basic knowledge about manufacturing processes. Students learn to understand the basic and some special manufacturing processes and their position within the production process. They understand the meaning of energy consumption and material use in industrial processes and are able to think about solutions for sustainable processes. The students get a basic understanding how industrial production works and get an appropriate toolkit to look on production processes with focus on economic and ecological aspects.

2 Module Content and Course Schedule

The lecture deals with the principles of manufacturing processes. It includes the following topics:

- Basic types of manufacturing processes
- Organization of production manufacturing types
- Special manufacturing processes and applications
- Clean production

3 Didactic Concept

- Lectures
- Guest lectures
- Samples and videos
- Study trips (optional)

4 Bibliography

Beitz, Wolfgang; Handbook of mechanical engineering / Dubbel; Springer

Mathematics I		MATHENG I
Duration	1 semester	
Study Semester	1st semester	
Frequency	Winter semester	
Recommended Prerequisites	None	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Integrated exercises	
Responsible for Module	Prof. Dr. Stephan Didas	
Teaching Personnel	Prof. Dr. Stephan Didas	
Requirement for Awarding of ECTS Points	Passed module examination Passing an intermediate test is required for registering for the final exam.	
Methods of Evaluation	☒ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

After the successful attendance of the course, students will be able to understand and apply basic notation of mathematical models. They will be able to perform basic arithmetic operations for complex numbers and functions and to model them for applications tasks. Students are able to analyze functions with one or more variables in terms of differential and integral calculus and to apply this in practical examples (e. g. in extreme value problems or for calculating areas and volumes). The students are able to explain the principle of approximation of a sufficiently smooth function by polynomials using the Taylor formula.

2 Module Content and Course Schedule

Content of the module is the understanding of mathematical models involving complex numbers and real functions of one and several variables:

1. Complex numbers
2. Sequences of real numbers and infinite sums
3. Functions
4. Limits and continuity
5. Differential and integral calculus in one real variable
6. Differential and integral calculus in more than one real variables
7. Taylor series

Course Schedule

1. Complex numbers and the basic operations with them are introduced.
2. A selection of elementary real functions is discussed in order to allow the students to understand models in engineering.
3. The basics of differential and integral calculus are presented and typical example problems are discussed.
4. The approximation of functions with polynomials via Taylor series is shown.

3 Didactic Concept

Lecture with integrated exercises, practicing by given example problems and potential tutorials.

4 Bibliography

K. Weltner, S. John, W. J. Weber, P. Schuster, J. Grosjean, Mathematics for Physicists and Engineers, Springer, 2014.

K. A. Stroud with D. J. Booth, Engineering Mathematics, 7th edition, Macmillan Education, 2013.

A. Croft, R. Davison, Mathematics for Engineers, 4th edition, Pearson Education, 2015.

Physics		PHYENG
Duration	1 semester	
Study Semester	1st semester	
Frequency	Winter semester	
Recommended Prere-quisites	None	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Exercises	
Responsible for Module	Dr. rer. nat., Tandem-Professor Tobias Roth	
Teaching Personnel	Dr. rer. nat., Tandem-Professor Tobias Roth	
Requirement for Award-ing of ECTS Points	Passed module examination	
Methods of Evaluation	☒ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

Students can describe physical phenomena or experiments of the module content by the usage of a precise scientific language in its different representations (textual in words, pictorial in diagrams or symbolic with equations). Based on the acquired skills typical tasks in the context of application can be solved exploiting physical concepts, laws or a combination of them, and presenting results with the correct terms. Beyond that, students are able to model or assess unknown problems by approximation, simplification or reduction to the learned fundamental laws and relations.

2 Module Content and Course Schedule

The lecture deals with the basics of physics and gives an introduction to the fields mechanics and optics.

It includes the following topics:

- Scientific method (theory vs experiment), hypothesis (verification vs falsification)
- Physical constants and quantities (SI units, prefactors)
- Handling physical equations, representing data in diagrams and reading the out

Mechanics

- Newton's Laws (definition of momentum, force, acceleration)
- Laws of motion (linear motion, accelerated motion)
- Representation and superposition of forces (inclined throw, inclined plane)
- Friction
- Gravitational law and field (gravitational constant, g-factor, potential)
- Conservation of energy and momentum
- Definition of power
- Galilei (and Lorentz) transformation
- Centrifugal and Coriolis force
- Rotational Motion (torque, angular momentum)
- Rigid body (center of mass, moment of inertia, rotational energy)
- Spinning top, conservation of angular momentum
- Harmonic oscillation (differential equation), pendulum
- Damping and resonance

Optics

- Relation between speed of light, wavelength and frequency
- Standing waves, Doppler effect
- Fermat's principle
- Reflection and refraction (Snell's law)
- Prism dispersion and rainbow
- Lens grinder equation
- Imaging equation
- Optical instruments (human eye, thin and thick lenses, lens errors, telescopes)
- Huygen's principle
- Interference
- Diffraction (slit, double slit, grating)
- Description of electromagnetic waves
- Polarization (Brewster angle)
- Laser principle (optional)

Course Schedule

1. Physics as a natural science is introduced by a short historical classification and an overview over the state-of-the-art with its basic concepts. Physical quantities and units are defined.

2. Some fundamental laws of mechanics and optics (e.g. Newton's Axioms, laws of motion, Snell's law, imaging equation), as well as principles (energy and momentum conservation, Fermat, Huygens) are presented, and its far-reaching consequences are discussed.

3 Didactic Concept

The learning content is motivated by its relevance for practice, linked to the students everyday life or job-related topics in industries and science. The lecture integrates

formats to deliberately address the student's participation by activating problem solving competencies in exercises. Moreover, the lecture is accompanied by a tutorial.

4 Bibliography

- Raymond A. Serway, John W. Jewett, Jr.: Physics for Scientists and Engineers with Modern Physics, 9th Edition, Brooks/Cole
- Paul A. Tipler, Gene Mosca: Physics for Scientists and Engineers, W. H. Freemann (2007)
- Mathew Sands, Richard Feynman, Robert B. Leighton: The Feynman Lectures on Physics

Principles of Engineering I		PRINENG I
Duration	1 semester	
Study Semester	2nd semester	
Frequency	Summer semester	
Recommended Prerequisites	Mathematics I, Physics	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Exercises	
Responsible for Module	Prof. Dr. Peter Gutheil, Prof. Dr. Thomas Preußler	
Teaching Personnel	Prof. Dr. Peter Gutheil, Prof. Dr. Thomas Preußler, Stefan Hirsch	
Requirement for Awarding of ECTS Points	Passed module examination	
Methods of Evaluation	☒ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

It is the goal of the lecture to learn the principles of Engineering. Students can understand and customize technical drawings and know basic contents of technical descriptions. The students know terms of forces and moments and understand the freeing principle. They can determine support reactions and inner forces by means of equilibrium conditions. The students know how to determine stresses in one-dimensional and plane state and the relation to corresponding strains.

2 Module Content and Course Schedule

The lecture deals with the principles of engineering. It includes the following topics:

- Technical drawings by means of computer aides methods
- DIN and other engineering standards
- Dimensioning and tolerances
- Forces and moments in the plane
- Freeing principle and balance of forces and moments
- Loads, reaction- and inner forces
- Normal-, shear- and equivalent stress
- Stress-strain relation and Hook's Law
- Strength and properties of materials

Course Schedule

1. Introduction on customizing technical drawings, dimensioning and tolerances.
2. Basic principles in static and mechanics of materials.
3. Calculation of forces and stress.

3 Didactic Concept

- Lectures
- Practices

4 Bibliography

Beitz, W. and K.-H. Küttner: Handbook of Mechanical Engineering, Springer

Hibbeler, R. C.: Engineering Mechanics – Statics, Pearson

Hibbeler, R. C.: Engineering Mechanics – Material Strength, Pearson

Hoischen, H.: Technisches Zeichen, Cornelsen

Principles of Engineering II		PRINENG II
Duration	1 semester	
Study Semester	3rd semester	
Frequency	Winter semester	
Recommended Prerequisites	Mathematics I, Physics, Principles of Engineering I	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Exercises	
Responsible for Module	Prof. Dr. Peter Gutheil	
Teaching Personnel	Prof. Dr. Peter Gutheil, Dr.-Ing. Lukas Lentz, Tandem-Professor, Stefan Hirsch	
Requirement for Awarding of ECTS Points	Passed module examination	
Methods of Evaluation	☐ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☒ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

The students can apply the principles of Engineering on simple structures such as rods and beams. Based on given loads, they can determine stresses and strains and transfer the knowledges on real applications. Students can understand technical systems and know basic methods to idealize machine elements and perform standardized dimensioning and analysis of machine elements. Furthermore, the students know the limits of dimensioning, strength and properties of materials and the basic definitions of static and dynamic load.

2 Module Content and Course Schedule

The lecture deals with the principles of Engineering. It includes the following topics:

- Basic load cases tension, pressure, bending and torsion
- Stress and strain on frames, rods, beams and shafts
- Smith Diagram
- Dynamic load, notch effect
- Design of machine elements
- Firmly bonded, form- and force-fitted bondings
- Bearings
- Screws and screw connections

Course Schedule

1. Basic principles in static and mechanics of materials.
2. Introduction to machine elements, basic principles and elements.
3. Design and analysis of machine elements.

3 Didactic Concept

- Lecture
- Practices

4 Bibliography

Beitz, W. and K.-H. Küttner: Handbook of Mechanical Engineering, Springer

Hibbeler, R. C.: Engineering Mechanics – Statics, Pearson

Hibbeler, R. C.: Engineering Mechanics – Material Strength, Pearson

Mott, R. L.: Machine Elements in Mechanical Design, 5th Edition, Pearson

Programming in Java		
Duration	1 semester	
Study Semester	6th semester	
Frequency	Summer semester	
Recommended Prerequisites	None	
Classification	☐ Required Course ☒ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	Same as credit points	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Integrated exercises	
Responsible for Module	Prof. Dr. Stephan Didas	
Teaching Personnel	Prof. Dr. Stephan Didas	
Requirement for Awarding of ECTS Points	Passed module examination	
Methods of Evaluation	☐ Written exam ☐ Oral exam ☐ Laboratory performance ☒ Project presentation	☐ Portfolio ☐ Term paper or essay ☒ Practical exam ☐ Colloquium

1 Learning Goals

This course enables the students to master the basics of the Java programming language and to use them in practical projects.

2 Module Content and Course Schedule

The lecture covers the basics of programming in Java. A modern general purpose programming language with application possibilities in almost all modern areas of computer systems is taught. The contents include:

- Basics of Java
- Control structures

- Data types
- Classes and Objects
- Exceptions, Threads, and Streams
- The basics of User Interface Programming

3 Didactic Concept

Lecture with integrated exercises, practicing by given example problems and a programming project.

4 Bibliography

- J. T. Streib, T. Soma: Guide to Java – A concise introduction to programming, 2nd edition, Springer, 2023.
- J. Barker: Beginning Java Objects – From Concepts to Code, 3rd edition, Apress, 2023.
- C. Ullenboom: Java ist auch eine Insel, Rheinwerk Computing, 17. Auflage, 2023.
  (In German, earlier editions are available as OpenBook.)

<table>
<tr><td colspan="3">Recent Topics on Internet of Things and Data Science (WP)</td><td>5 ECTS</td></tr>
<tr><td>Modulkürzel/Module code:
RTID</td><td colspan="2">Workload:
150 Stunden</td><td>Dauer/ Duration:
1 Semester</td></tr>
<tr><td>Lehr-/Lernformen/
Didactic concept:
Seminar und Projekt</td><td>Präsenzzeit/
Contact hours:
2 SWS/ 22,5 h</td><td>Selbststudium/
Self-study:
127,5 h</td><td>Geplante Gruppengröße/
Group size:
20 Studierende</td></tr>
<tr><td colspan="4">Verwendbarkeit des Moduls/ Applicability of the module:
As compulsory module: -
As compulsory elective module: see compulsory elective module catalogue (homepage under "Info for the current semester")</td></tr>
<tr><td colspan="4">Lernergebnisse/Kompetenzen/ Learning goals:
- Internet of Things (IoT) in combination with data science is a disruptive technology. Especially the storage and processing of the data of those systems requires a knowledge in multiple disciplines, such as: data bases, information management, knowledge management, decision making, and machine learning.
- After this course, the students have the following skills:
o The students know on recent topics of current third-party-funded projects and are able to work scientifically, such as solving technical problems, algorithm development, and writing a research paper.
o The students know use cases of different areas where IoT and data science is applied, such as: business computer science, applied computer science, environmental science, logistics, mobility, industry, and medicine.</td></tr>
<tr><td colspan="4">Inhalte/ Module Content:
Possible topics in this course are:
o Applying data bases on recent IoT problems
o Modelling of technical problems
o Development and implementation of
▪ information management systems, and/or
▪ decision making systems, and/or
▪ machine learning tools
o Organization of a small research project
o Documentation of results and scientific writing</td></tr>
<tr><td colspan="4">Empfehlung für die Teilnahme/ Recommendations for participation:
Analysis and Statistics</td></tr>
<tr><td colspan="4">Vergabe von Leistungspunkten/ Requirement for awarding of ECTS points:
The grade and credit points are awarded on the basis of a term paper/project report.</td></tr>
<tr><td colspan="4">Umfang und Dauer der Prüfung/ Scope and duration of the examination:Allgemeine
General regulations concerning the type and scope as well as the performance and grading of study and examination achievements are defined in the examination regulations of the respective degree programme. The type of proof of achievement as well as precise notes and details will be announced by the respective lecturer at the beginning of the semester.</td></tr>
<tr><td colspan="4">Stellenwert der Note für die Endnote/Gewichtung/ Weight of grade (% of credit):</td></tr>
</table>

5/165 (3.03 %) for 6-semester degree programmes; 5/180 (2.78 %) for 7-semester degree programmes with a practical semester; 5/195 (2.56 %) for 7-semester degree programmes without practical semester
Häufigkeit des Angebotes/ **Frequency:** Winter and summer semester
Modulverantwortliche/r/ **Responsible for module:** Prof. Dr.-Ing. Guido Dartmann, Prof. Dr-Ing. Klaus-Uwe Gollmer, Prof. Dr. phil. nat. Rolf Krieger, Prof. Dr. rer. nat. Stefan Naumann
Literatur/ **Bibliography:** Learning from Data - Abu-Mostafa

Remote Sensing		
Duration	1 semester	
Study Semester	5th semester	
Frequency	Winter semester	
Recommended Prere-quisites	None	
Classification	☐ Required Course ☒ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Seminar, Practicals	
Responsible for Module	Prof. Dr. Peter Fischer-Stabel	
Teaching Personnel	Prof. Dr. Peter Fischer-Stabel	
Requirement for Award-ing of ECTS Points	Passed module examination	
Methods of Evaluation	☐ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☒ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

Students will gain key knowledge in remote sensing technologies. They will be able to analyze various types of remotely sensed data (e. g. optical, radar, lidar etc.), to define appropriate algorithms, and to critically discuss the quality of the results of their analyses.

On the basis of the acquired knowledge, students will be able to recognize the benefits remotely sensed data have, especially with view to the recent discussion addressing hot topics such as climate change, loss in biodiversity, natural and technological disaster or atmospheric pollution, to name but a few. On the other hand, the students will be able to deal with the limits of remote sensing technologies compared to In-Situ-Methods.

2 Module Content and Course Schedule

The seminar presents and discusses key terms and theories of remote sensing technologies and applications.

Within the accompanying practicals the participants will learn methods, tools and operational systems mainly in the context of environmental monitoring. They will be able to develop simple algorithms in image processing, to extract feature based information at the earth surface. In addition, an overview of data providers, related web services and high-level-products is given.

Course Schedule

1. The what, why and how of remote sensing
2. Geospatial reference systems
3. Multispectral and radar systems
4. Lidar and Sonar systems
5. Digital image processing and analysis
6. Common applications in environmental monitoring

3 Didactic Concept

- Lecture and interactive workshop elements
- Integration of web media
- Practicals using up-to-date/global space-based data and open source software

4 Bibliography

Lillesand T., R. Kiefer, J. Chipman (2015): Remote Sensing and Image Interpretation.- 7th Edition, Wiley & Sons

Maguire, Goodchild, Rhind (2005): Geographical Information Systems and Science.- John Wiley & Sons, New York.

Solar Energy		
Duration	1 semester	
Study Semester	6th semester	
Frequency	Summer semester	
Recommended Prerequisites	Knowledge of electrical engineering and physics	
Classification	☐ Required Course ☒ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 45 h	
Self-Study	105 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture	
Responsible for Module	Prof. Dr. Henrik te Heesen	
Teaching Personnel	Prof. Dr. Henrik te Heesen	
Requirement for Awarding of ECTS Points	Passed module examination Grade and credit points are awarded based on portfolio examination. The portfolio examination consists of exercises that accompany the course and a written exam at the end of the course. Both exams must be passed to complete the course successfully. The overall grade is calculated as the average of both partial tasks.	
Methods of Evaluation	☐ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☒ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

The learning objectives of the Solar Energy module focus on providing an understanding of photovoltaic systems. Students will learn the principles of converting solar en-

ergy into electricity, the structure of solar cells and modules, and a photovoltaic system's components and life cycle. In addition, they will become familiar with technical terms and scientific concepts and develop analytical skills to address technical issues in the renewable energy field. The goal is to equip students with the knowledge and skills needed to contribute effectively to the growth and development of renewable energy technologies. Achieving these learning objectives will provide students with a solid foundation in photovoltaics.

2 Module Content and Course Schedule

Fundamentals of Solar Energy: This section covers the basic principles of solar energy and its conversion into usable electricity through photovoltaic systems. The underlying physical and engineering concepts are discussed in detail.

Design of solar cells and modules: This section covers the design and operation of solar cells and modules, including the impact of design on overall system efficiency. Emphasis is placed on technical considerations such as material selection, cell geometry, and operating conditions.

Components of a Photovoltaic System: The various components of a photovoltaic system, including inverters, grid integration, and monitoring systems, are described and analyzed in this section. Students will learn to understand these components' role in ensuring the system's overall functionality and their impact on system performance.

Photovoltaic System Life Cycle: This section covers the life cycle of a photovoltaic system, including key phases such as design, construction, and operation. Students will become familiar with the technical and operational considerations that play a role in each phase and the importance of each phase to the successful implementation and sustainability of the system.

Technical Knowledge and Analytical Skills: This section allows students to apply their knowledge to real-world situations and critically analyze and address technical issues in the renewable energy field. Emphasis is placed on developing technical knowledge and analytical skills that will be useful in future careers in the renewable energy field.

3 Didactic Concept

Seminar with exercises

The concept of the teaching form is "Flipped Classroom": The students acquire the content basics through guided self-study, the attendance time is used for the joint processing of assignments.

4 Bibliography

Quaschning, Volker. Renewable Energy and Climate Change. Wiley. 2010

DGS. Planning and Installing Photovoltaic Systems. Routledge. 2013

Educational videos on solar energy engineering

Further literature will be announced during the course

Specialized Project Work		**5 ECTS**
Module code: FP	**Workload:** 150 hours	**Duration:** 1 Semester
Didactic concept: Project work	**Contact hours/Self-study:** 150 h	**Group size:** 1-4 students

Applicability of the module:
As compulsory module: EE, AI, MI, UI
As compulsory elective module: see compulsory elective module catalogue (homepage under "Info for the current semester")

Learning goals:
After completing the module, students are able to independently apply various practice- and theory-oriented methods and techniques in the development of a project. Students are able to plan, carry out and organize research and development tasks independently. They are also able to present the course of the project and derive conclusions from the results.

Module Content:
The module teaches scientific methodology and skills under the guidance of a supervising professor. A more complex piece of work is carried out, which is characterized by a scientific approach and an appropriate methodology.
This module focuses on teaching subject-specific methods. A project can also be carried out with external partners from institutes, universities and industry.

Recommendations for participation:
none

Requirement for awarding of ECTS points:
The grade and credit points are awarded on the basis of the project work in combination with the oral project presentation.

Scope and duration of the examination:
General regulations concerning the type and scope as well as the performance and grading of study and examination achievements are defined in the examination regulations of the respective degree programme. The type of proof of achievement as well as precise notes and details will be announced by the respective lecturer at the beginning of the semester.

Weight of grade (% of credit):
5/165 (3.03%) for 6-semester programmes;
5/150 (3.3%) for dual study programme D-PT;
5/180 (2.78%) for 7-semester programmes with internship semester;
5/195 (2,56 %) for 7-semester programmes without internship semester.

Frequency:
every semester

Responsible for module:
all lecturers from the subject area

Bibliography:

Depending on the topic, helpful literature will be announced when the topic is assigned. In addition:

Balzert, H., C. Schäfer, M. Schröder
U. Kern: Wissenschaftliches Arbeiten. 1. Auflage, Herdecke 2008

Sustainable Energy Systems		SUENSY
Duration	1 semester	
Study Semester	4th semester	
Frequency	Summer semester	
Recommended Prere-quisites	Physics and Thermodynamics	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Seminar	
Responsible for Module	Prof. Dr. Henrik te Heesen	
Teaching Personnel	Joachim Brinkmann, M. Sc.	
Requirement for Award-ing of ECTS Points	Passed module examination	
Methods of Evaluation	☒ Written exam (75%) ☐ Oral exam ☐ Laboratory performance ☒ Presentation (25%)	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

Students have acquired basic knowledge of the energy sector. The students are able to apply the acquired knowledge with regard to current approaches in energy technology.

2 Module Content and Course Schedule

The module contains an introduction to the topic of energy. This includes units, forms of energy and basic concepts such as primary energy and the distinction between fossil and renewable sources of energy. These include the residential sector (building energy technology) as well as electricity generation and distribution and transport technology. The lecture considers current approaches in energy technology, in particular:

- Energy demand, generation, and transportation
- Fossil energy systems
- Renewable energy systems
- Heat demand
- Transportation
- Sector coupling
- Climate change
- Energy hub concepts

3 Didactic Concept

Seminar-like lessons with exercises.

4 Bibliography

Volker Quaschning. Understanding renewable energy systems. Earthscan/ Routledge London. 2016.

Additional references will be given during the course

Thermodynamics		THERMO
Duration	1 semester	
Study Semester	2nd semester	
Frequency	Summer semester	
Recommended Prerequisites	Analysis, Physics	
Classification	☒ Required Course ☐ Compulsory Optional Subject	
Credit Points	5	
Weight of Grade	2.78%	
Contact Hours	4 SWS / 60 h	
Self-Study	90 h	
Total Workload	150 h	
Course Language	English	
Type	Lecture, Exercises	
Responsible for Module	Dr. rer. nat., Tandem-Professor Tobias Roth	
Teaching Personnel	Dr. rer. nat., Tandem-Professor Tobias Roth	
Requirement for Awarding of ECTS Points	Passed module examination	
Methods of Evaluation	☒ Written exam ☐ Oral exam ☐ Laboratory performance ☐ Project presentation	☐ Portfolio ☐ Term paper or essay ☐ Practical exam ☐ Colloquium

1 Learning Goals

Students can describe thermodynamic phenomena or experiments of the module content by the usage of a precise scientific language in its different representations (textual in words, pictorial in diagrams or symbolic with equations). Based on the acquired skills typical tasks in the context of application can be solved exploiting thermodynamic concepts, laws or a combination of them, and presenting results with the correct terms. Beyond that, students are able to model or assess unknown problems by approximation, simplification or reduction to the learned fundamental laws and relations. More specifically, they can quantify thermal energy conversion in technical processes by means of a system abstraction and using suitable tools from thermodynamic modelling (balancing, state equations or material models).

2 Module Content and Course Schedule

The course teaches the basics of thermodynamics. For this purpose, macroscopic/empirical laws (ideal, real gas law) are introduced, starting from state variables. Using the concept of entropy, the Maxwell-Boltzmann velocity distribution and Planck's radiation law, the statistical nature of thermodynamics is introduced. In the context of the second fundamental law of thermodynamics technically relevant thermal cycles are described. In addition, phase transitions are covered.

- Introduction to thermodynamics (state variables, heat, internal energy)
- Definition of temperature and its measurement
- Linear expansion (Lennard-Jones potential)
- Calorimetry and heat capacity (Dewar vessel)
- Phase transition and phase diagrams (latent heat, fridge principle, memory alloys)
- Ideal gas model (standard conditions) versus real gas model
- Microscopic description (Maxwell-Boltzmann speed distribution)
- Climate change (thermodynamics of oceans and atmosphere)
- Mechanism of heat transfer (conduction, convection, radiation)
- Fundamental laws of thermodynamics (entropy)
- Thermodynamic cycles (Carnot process, heat pump, chiller, Diesel/Otto engine)

3 Didactic Concept

The learning content is motivated by its relevance for practice, linked to the students' everyday life or job-related topics in industries and science. The lecture integrates formats to deliberately address the student's participation by activating problem solving competencies in exercises. Moreover, the lecture is accompanied by a tutorial.

4 Bibliography

- Raymond A. Serway & John W. Jewett, Jr.: *Physics for Scientists and Engineers*. Brooks Cole Pub Co, 10th Edition (2018)
- Hugh D. Young & Roger A. Freedman: *University Physics with Modern Physics*. Pearson Education Limited, 15th Edition (2020)
- Paul A. Tipler & Gene Mosca: *Physics for Scientists and Engineers with Modern Physics*. W. H. Freeman, 6th Edition (2021)