OTH REGENSBURG

Module handbook

for the Bachelor's degree programme

International Electrical Engineering (B.Eng.)

SPO version from: Winter semester 2025/26

Summer semester 2025

created on 06.05.2025 by

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Opening credits

Please note: This document is only a draft. The "International Electrical Engineering" degree programme is expected to start for the first time in winter semester 2025/26. The final version of the module handbook will be published in mid-October 2025. In the meantime, changes/updates may still be made to the document.

1. Explanations on the structure of the module handbook

The modules are sorted alphabetically. Each module is assigned one or more courses whose description follows directly after the module. Click on the entries in the table of contents to go directly to the respective description in the module handbook.

The information regarding the total time required for each module is made up of the criteria attendance time in lectures, preparation and follow-up work, self-study and, if applicable, project work and presentation. This is based on the time required for the degree programme of 30 hours per credit and semester.

2. Learning objectives

The module handbook lists the learning objectives of the individual modules based on the competences acquired. These are divided into "Professional competence" (knowledge, skills) and "Personal competence" (social competence, independence). Each competence is assigned to a level by means of an expression in brackets (1-3). The three levels are divided into "Knowledge" (level 1),
"Ability" (level 2) and "Understanding and application" (level 3).

In addition to teaching new subject-specific skills, the teaching of personal skills is of course an integral part of every course or a university degree programme in general. Unless further specified in the description of a module, students who have successfully completed a module are able to

- analyse their own learning progress and learning needs (3) and, if necessary, derive courses of action from this (3),
- work together with others in a goal-orientated way (2), understand their interests and social situation (2), deal with them rationally and responsibly and communicate with them (2) and help shape their working and living environment (3),
- to work scientifically in accordance with the "rules of good scientific practice" (2), to present specialised content (2) and to present to an audience in correct technical language (2).

Furthermore, for laboratory practical modules in particular, students who have successfully completed the module are able to

- Know the five safety rules (1) and apply them (2)
- maintain a risk-conscious approach to electrical voltage (2), assess the effects on their own health (3) and implement appropriate safety measures if necessary (2).

3. Standard tools

The following aids are permitted for all examinations:

- Writing pens of all kinds (except red pens)
- Compasses, rulers of all kinds, eraser, pencil sharpener

Exceptions to this rule are explicitly stated in the column "Authorised aids". For examinations marked "none", the standard aids are permitted. The pocket calculators authorised in the Faculty of Electrical Engineering and Information Technology ("standard pocket calculators") are Casio FX-991, Casio FX-991 PLUS, Casio FX-991DE X (to be purchased e.g. via the student council). Unless expressly stated otherwise, only these models are permitted as aids (if pocket calculators are permitted as aids in a course). You can obtain paper from the examination supervisor if required.

Please also note that any use of communication devices (telephones, watches, glasses, etc.) is prohibited.

4. Applicability of the modules

The modules listed in the module handbook apply to the degree programme in the module handbook. Further use beyond this is defined by the compulsory elective module catalogue of the respective degree programmes.

Module list

Study section 1:

Study section 2:

Study section 3:

Specialisation: Subject-specific compulsory elective module

Module name (English name if applicable)	Module code or no.
Digital Technology (Digital Electronics)	5

Person responsible for the module	Faculty
Prof Dr Thomas Fuhrmann	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
1	1	Compulsory	5

Recommended prior knowledge
Good knowledge of maths about number representation, binary numbers, power calculation. From Computer Science 1 C programming, the use of control structures (if-then- else switch-case, for, while) and the elementary integer data types (int, char, array) as well as basic knowledge of binary logical bit operations.

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Digital technology	4 SWS	5

Submodule	**TM abbreviation**
Digital technology	**DT**

Responsible person	Faculty
Prof Dr Thomas Fuhrmann	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Florian Aschauer Prof. Dr Thomas Fuhrmann Prof. Dr Christian Schimpfle	in each semester

Teaching form
Lecture, seminar-style teaching, exercises (10 - 15%)

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	4 SWS	English	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up: 60 h Exam preparation: 30 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Number theory of bit vectors as a technical application of binary numbers
- Digital circuits (gates, signals, logic families, output circuits)
- Design of combinatorial logic (switching networks, examples)
- Design of sequential logic (switching systems, state machines, examples)
- Diagrams and shapes for visualising specific circuit aspects
- Structural design of programmable logic devices
- Basics of programmable logic with the use of VHDL

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- analyse, design, minimise and optimise digital circuits using the switching algebra calculus (3)
- use basic logical functions safely in various technical development contexts in hardware and software (3)
- understand the structure of microcomputer components and other digital components for in-depth study in subsequent courses (2)
- fundamentally recognise, analyse and expand digital circuits (1)

- analyse and understand the modular structure of basic digital circuits (2)
- use digital circuits based on two-valued logic in all forms (2)
- synthesise and simulate digital circuits in VHDL, prepared for in-depth study in the practical course (2)
- express simple processes by means of programming in VHDL (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises with solutions, data sheets, bibliography
Teaching media
Blackboard, computer/beamer
Literature
Digitaltechnik Elektronik-4 ; Klaus Beuth ; Vogel Buchverlag, 2007 Paperback Digital Technology ; Christian Siemers, Axel Sikora (editors); Fachbuchverlag Lehrbuch Digitaltechnik: Eine Einführung mit VHDL ; Jürgen Reichardt ; Oldenbourg Wissenschaftsverlag,2016

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Electrical Measurements 1 (Electrical Measurements 1)	14

Person responsible for the module	Faculty
Prof Dr Heiko Unold	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
3	1	Compulsory	5

Recommended prior knowledge
Fundamentals of electrical engineering

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Electrical measurement technology 1	2 SWS	3
2.	Practical course in electrical measurement technology 1	2 SWS	2

Submodule		**TM abbreviation**
Electrical measurement technology 1		**MT1**
Person responsible	Faculty	
Prof Dr Heiko Unold	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Mikhail Chamonine Prof. Dr Bernhard Hopfensperger Prof. Dr Heiko Unold	in each semester	
Teaching form		
Inverted classroom with preparation tasks		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
3	2 SWS	English	3

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 62 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Basics of measurement (units, logarithmic measures, sensitivity) • Dealing with measurement uncertainties (normal distribution, error propagation) • Digital multimeter (AD converter, measuring range extension, four-wire measurement) • Oscilloscope (principle, characteristics, operation and interpretation of measurements on a digital storage oscilloscope) • Digital frequency and period duration measurement • Operational amplifiers (principle of ideal OPV, amplifier, arithmetic and comparator circuits)
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Interpret and apply metrological units and measures (incl. logarithmic measures) (3) • Interpret and apply basic terms of measurement technology (accuracy, resolution, sensitivity,...) (3) • use basic concepts of measurement uncertainties, statistics and error calculation (2) • Describe the functional principle of a multimeter (3)

- To illustrate the operating principle of an oscilloscope (3) and to handle an oscilloscope (2)
- interpret and apply basic concepts of time and frequency measurement (3)
- Describe the basic function of the operational amplifier to (1) and to handle (2) and calculate (2) basic operational amplifier applications (e.g. measuring amplifier) on this basis.
- Calculate simple metrological circuits including measurement uncertainties (2)
- Analyse (3) and calculate (2) simple operational amplifier circuits
- analyse (3) and solve (3) simple metrological problems from an engineering perspective

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, preparation tasks with solutions
Teaching media
Interactive GRIPS course, projector/chalkboard
Literature
Hoffmann, Jörg: Taschenbuch der Messtechnik, Hanser-Verlag 2007 Lerch, R.: Elektrische Messtechnik, Springer-Verlag 2012 Schrüfer, E.: Elektrische Messtechnik, Hanser-Verlag 2012

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	**TM abbreviation**
Practical course in electrical measurement technology 1	**PMT1**

Responsible person	Faculty
Prof Dr Heiko Unold	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Claus Brüdigam Prof. Dr Mikhail Chamonine Prof. Dr Thomas Fuhrmann Prof. Dr Bernhard Hopfensperger Prof. Dr Anton Horn Prof. Dr Johannes Reschke Prof. Dr Robert Sattler Prof. Dr Heiko Unold Prof Dr Andreas Voigt	in each semester

Teaching form
Laboratory practicals

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
3	2 SWS	English	2

Time required:

On-campus study programme	Self-study
15 h	Preparation and follow-up: 45 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Four experiments from the field of fundamentals of electrical measurement technology including the following topics: • Digital multimeter (DC, AC, mixed variables) • Oscilloscope (operation, input impedance, AC/DC operation, mean values, sampling theorem, probe) • Simple signal processing using operational amplifiers • Measurement technology for signal propagation (ultrasound) • Non-linear two-pole • Transistor characteristics and heat conduction • Determination of alternating current resistances, frequency dependence • Alternating current measuring bridge, real coil

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Set up and commission simple electrical circuits using sockets (3) • use simple electrical laboratory and measuring equipment in a targeted manner (multimeter, oscilloscope, sources) (2) • document an experimental setup and record measurement data (2) • Systematically analyse measurement data (2) • deal with measurement uncertainties (1)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • Meeting attendance and submission deadlines (3) • prepare adequately for the contents of the experiment using the experiment instructions (3) • work together constructively in a group (2) • create meaningful test protocols (2) • scrutinise measurement data/structures in the event of discrepancies (1) • present an experimental procedure including the associated basic principles to a group and answer questions (2)
Training materials offered
Test instructions, data sheets
Teaching media
Laboratory
Literature
Hoffmann, Jörg: Taschenbuch der Messtechnik, Hanser-Verlag. Lerch, R.: Elektrische Messtechnik, Springer-Verlag. Schrüfer, E.: Elektrische Messtechnik, Hanser-Verlag. Tietze, U.: Halbleiter-Schaltungstechnik, Springer-Verlag.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Electronic components (Electronic Components)		16
Person responsible for the module	Faculty	
Prof Dr Rainer Holmer	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
3	1	Compulsory	5

Recommended prior knowledge
Fundamentals of electrical engineering 1 and 2

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Electronic components	4 SWS	5

Submodule		**TM abbreviation**
Electronic components		**BE**
Responsible person	Faculty	
Prof Dr Rainer Holmer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Rainer Holmer Prof Dr Christian Schimpfle	in each semester	
Teaching form		
Seminar-based teaching with 10 - 15 % exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
3	4 SWS	English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 56 h Exam preparation: 38 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Fundamentals of semiconductor physics: • Semiconductor materials • Crystal structure, carrier densities, conduction mechanisms • Electrical properties (drift and diffusion current) • Equalisation processes when the thermal equilibrium is disturbed • Belt model **Diode:** • Basic structure and behaviour without external voltage • pn junction in forward and reverse polarity • dynamic behaviour, breakthrough mechanisms • Static and dynamic models • Simple applications • Technological realisation • Diode types **Bipolar transistor:** • Principle of operation • Technological structure • Current equations, operating modes • Basic circuits • Characteristics and characteristic curves • Temperature and breakthrough behaviour • Static and dynamic models • Simple applications **Field effect transistor:** • MOS capacitor • MOS and junction field effect transistor • Technological structure • Principle of powerless control • Characteristics and characteristic curves • Static and dynamic models • ApplicationsPower MOSFET, IGBT
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Be able to present important basics of semiconductor physics (2) • Analyse the functioning of diodes, bipolar and field-effect transistors on the basis of their internal structure (3) • interpret characteristics and characteristic curves of the components (3) • Connections between technological and electronic parameters of the components (2) • understand and apply models to describe static and dynamic behaviour (3)

- Absolute and comparative evaluations of electronic components based on data sheets of the manufacturers (2)
- Carry out a selection of suitable electronic components for given requirements (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, bibliography
Teaching media
Blackboard, computer+ Projector
Literature
[1] Müller R.: Grundlagen der Halbleiter-Elektronik (book series "Halbleiter-Elektronik, Band 1),Springer-Verlag, 1995 [2] Müller R.: Bauelemente der Halbleiter-Elektronik (Book series "Semiconductor Electronics, Volume 2), Springer-Verlag, 1991 [3] Sze S.M., Ng K.K.: Physics of Semiconductor Devices, John Wiley & Sons, 2006 [4] Hoffmann K., VLSI Design: Models and Circuits, Oldenbourg Wissenschaftsverlag, 1998 [5] Tietze U., Schenk C.: Semiconductor Circuit Technology, Springer Verlag, 2012

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Fundamentals of Electrical Engineering 1.1 (Electrical Engineering 1.1)		3
Person responsible for the module	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
1	1	Compulsory	4

Mandatory requirements

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Fundamentals of electrical engineering 1.1	4 SWS	4

Submodule	**TM abbreviation**
Fundamentals of electrical engineering 1.1	**GE1.1**

Person responsible	Faculty
Prof Dr Robert Sattler	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Mathias Bischoff Prof. Dr Susanne Hipp Prof. Dr Anton Horn Prof. Dr Robert Huber Prof. Dr Robert Sattler Prof. Dr Oliver Sterz Prof. Dr Thomas Stücke	in each semester
Teaching form	
Seminar-based teaching: 10-15% exercise component	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	4 SWS	English	4

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up 40 h; Exam preparation 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Direct current Basic concepts of the electrical circuit: current strength, current density, energy, voltage and potential, power loss, efficiency, electric heat Two poles (active and passive, linear and non-linear), Ohm's law, electrical resistance and its temperature dependence Calculation of direct current networks: Application of Kirchhoff's theorems (current and voltage dividers), active and passive equivalent two-pole, (two-pole theory analytical and graphical), superposition methods, nodal voltage and mesh current methods
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Know the basic concepts and physical laws of the direct current circuit (Kirchhoff theorems) (1).

- use the acquired knowledge to solve known types of tasks in the field of
  (2): Calculation of voltages, currents and power in an electrical network with multiple sources and linear and non-linear resistances using analytical and graphical methods.
- understanding the underlying physical laws to solve previously unknown problems in the field of direct current networks (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, worksheets, bibliography
Teaching media
z. e.g. blackboard, projector
Literature
"Electrical Engineering: Principles and Applications" by Allan R. Hambley "Introduction to Electric Circuits" by Richard C. Dorf and James A. Svoboda "Fundamentals of Electric Circuits" by Alexander and Sadiku "Principles of Electric Circuits: Conventional Current Version" by Thomas L. Floyd "Electromagnetic Fields and Waves" by William H. Hayt and John A. Buck

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Fundamentals of Electrical Engineering 1.2 (Electrical Engineering 1.2)		9
Person responsible for the module	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
2	1	Compulsory	5

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Fundamentals of electrical engineering 1.2 (Electrical Engineering 1.2)	4 SWS	5

Submodule		TM abbreviation
Fundamentals of Electrical Engineering 1.2 (Electrical Engineering 1.2)		**GE1.2**
Responsible person	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Mathias Bischoff Prof. Dr Susanne Hipp Prof. Dr Anton Horn Prof. Dr Robert Huber Prof. Dr Robert Sattler Prof. Dr Oliver Sterz Prof. Dr Thomas Stücke	in each semester	
Teaching form		
Seminar-based teaching: 10-15% exercise component		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	4 SWS	English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up 58 h; Exam preparation 36 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Stationary magnetic field Basic concepts of the magnetic field: freedom from sources, superposition principle, magnetic flux density and (chained) flux, permeability, magnetic field strength, magnetic dipole moment Calculation of magnetic fields of coils and lines with the aid of the flow law and Biot-Savart's law, energy and forces of the magnetic field Matter in a magnetic field and behaviour of fields at interfaces. Calculation magnetic circles • Unsteady magnetic field Law of induction, inductance of coils and cables, Magnetically coupled coils, mutual inductance, coupling factors Switching processes in circuits with inductances

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Know the basic concepts and physical laws of the direct current circuit (Kirchhoff theorems) (1). • apply the acquired knowledge to solve known types of tasks in the field of magnetic fields (2): Calculation of magnetic fields and inductance of simple current curves, calculation of (un)branched magnetic circuits for given material characteristics. • understanding the underlying physical laws to solve previously unknown problems in the field of magnetic fields (3).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Teaching media
Exercises, worksheets, bibliography
Literature
Engineering Electromagnetics from Ida Engineering Electromagnetics from Hayt

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Fundamentals of Electrical Engineering 2 (Electrical Engineering 2)	15

Person responsible for the module	Faculty
Prof Dr Robert Sattler	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
3	1	Compulsory	8

Recommended prior knowledge
GE1

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Fundamentals of Electrical Engineering 2	8 SWS	8

Submodule	**TM abbreviation**
Fundamentals of Electrical Engineering 2	**GE2**

Responsible person	Faculty
Prof Dr Robert Sattler	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Mathias Bischoff Prof. Dr Susanne Hipp Prof. Dr Anton Horn Prof. Dr Robert Huber Prof. Dr Robert Sattler Prof. Dr Oliver Sterz Prof. Dr Thomas Stücke	in each semester
Teaching form	
Seminar-based teaching: 10-15% exercise component	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
3	8 SWS	English	8

Time required:

On-campus study programme	Self-study
112 h	Preparation and follow-up: 80 h Exam preparation: 48 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Stationary electric flow field and, electrostatic field and switching processes Basic concepts: electric field, voltage, potential, permittivity, current density, capacitance, electric flux (density), displacement current (density), influence and polarisation. Calculation of electrostatic fields using Gauss' law and calculation of electric flow fields. Energy and forces in the electrostatic field. Conductors and non-conductors in the electrostatic field and behaviour of the fields at the interfaces. Switching processes in circuits with capacitances. • Alternating current networks Basic terms: complex currents and voltages, pointer diagram, complex resistance, complex power, active and reactive power Calculation of currents, voltages and power in networks with multiple sources and passive components. Calculation and construction of locus curves Technical resistors, capacitors and coils for alternating current: Characteristics, equivalent circuits. • Three-phase systems Calculation of currents, voltages and power for balanced and unbalanced loads in star and delta connection in a three- or four-wire network. Design of power factor correction • Transformer Ideal transformer Real transformer with consideration of leakage losses and winding resistances: Transformer equations, symmetrical and asymmetrical equivalent circuit diagrams, frequency behaviour • Resonant circuits Basic concepts: resonant frequency, cut-off frequency, bandwidth, quality, resonance boost Frequency behaviour of series and parallel resonant circuits, Resonance of linear passive two poles (resistance transformation, multiple resonances)

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Know the basic concepts and physical laws of electric fields (Maxwell's equations) and the alternating current circuit (1).

- use the acquired knowledge to solve known types of tasks in the field of
  of the electric field and the flow field (2): Calculation of the local field quantities (D-, E-field and current density) and calculation of the integral quantities (capacitance and resistance) for simple conductor arrangements. Calculation of the time course of the charging and discharging processes of capacitors.
- apply the acquired knowledge to solve known types of tasks in the field of alternating current networks (2): Calculation of voltages, currents and power in an electrical network with several sources and linear passive components. Construction of locus curves and pointer diagrams. This applies in particular to three-phase systems, transformers and resonant circuits.
- with an understanding of the underlying laws of physics for the solution
  The aim is to answer previously unknown questions in the field of electric fields and alternating current networks (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, worksheets, bibliography
Teaching media
e.g. blackboard, projector
Literature
Führer, Heidemann, Nerreter: Fundamentals of Electrical Engineering, Vol. 1-3, Hanser-Verlag Hagmann: Fundamentals of Electrical Engineering, Aula-Verlag Pregla: Fundamentals of Electrical Engineering, Hüthig-Verlag Moeller, Fricke, Vaske, Frohne: Fundamentals of Electrical Engineering, Teubner-Verlag

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Computer Science 1 (Computer Science 1)		2
Person responsible for the module	Faculty	
N.N.	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
1	1	Compulsory	6

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Computer science 1	4 SWS	4
2.	Internship Computer Science 1	2 SWS	2

Submodule	**TM abbreviation**
Computer science 1	**IN1**

Responsible person	Faculty
	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
N.N.	in each semester

Teaching form
Lecture with 20% exercises

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	4 SWS	English	4

Time required:

On-campus study programme	Self-study
45 h	Preparation and follow-up: 59 h (prerequisite for PIN1); exam preparation: 16 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
The course teaches the basic concepts of procedural programming and the execution model of the C language. The abstract basic concepts as well as their implementation in the C language are covered so that students without previous programming knowledge also have the opportunity to follow the course. The following topics are dealt with in particular: **Basic concepts of procedural programming** • Structure of procedural programmes in C: definitions, declarations, instructions, Expressions, functions • Elementary data types: Declaration, Definition, data types, value ranges, internal representation, literal constants, constants, arrays, structure data types • Operators and expressions: Value and side effect, unary or binary operators, • Operator precedence, expressions, families of operators (bitwise, logical, arithmetic, assignment and comparison operators and special operators) • instructions and control structures: Expression statement, multiple statements, branches, loops, functions and function calls • Execution model of the C language: functions, memory model, memory management, parameter mechanism, pointer • Preprocessor: preprocessor symbols, replacement mechanism, conditional compilation, include mechanism, predefined symbols • Using the standard library **Applications of procedural programming** • Applications and algorithm families: state machines, sorting methods, random numbers and Monte Carlo algorithms, iterative methods, recursion, simple graphics programming, simple linked lists • File accesses: Creating, reading and writing files, formatted input and output, line-by-line input and output, binary input and output **Development tools** • The translation process: preprocessor, compiler, linker, multi-part programmes • Efficient use of the development environment • Troubleshooting and using the debugger
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to solve programming problems independently using procedural programming. **The following knowledge (1) is acquired by the participants of the course for this purpose (10 %):** • Basic concepts and terms of the procedural programming; Knowledge of the corresponding English technical terms • Basic language elements of C • Knowledge of simple standard algorithms • Basic knowledge of development tools and execution model

- Basic insight into the importance of non-functional properties (maintainability, development effort, minimal redundancy in the source code, efficient efficient execution, economical use of hardware resources) as well as in possibilities of realisation.

The following skills (2) are acquired by the participants of the course (60 %):

- Implementation of existing algorithms in C
- Understanding foreign implementations
- Independent design of your own simple algorithms
- Presentation of self-developed software solutions and discussion of controversial solutions
- Independent creation of procedurally structured software designs and their correct implementation
- Dealing with development environments
- Independent use of debugging tools for troubleshooting

The following technical and non-technical competences (3) are acquired by the participants of the course for this purpose (30 %):

- Independent problem analysis and structured problem-solving thinking
- Independent solution of low to moderately complex problems by designing C programmes
- Assessment of the plausibility of programme results
- Testing, debugging and troubleshooting your own and third-party C programmes

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to assess the importance of careful, independent work for their learning success. Personal competences are not primarily taught explicitly in this course, but in particular interwoven with the professional competences and tested as far as possible. See therefore also under "Professional competence".
Training materials offered
Script (Computer Science for Engineers, see bibliography), programmes from the lecture, bibliography
Teaching media
Blackboard, computer with development environment, projector, supplementary documents in the associated eLearning course
Literature

- Böttcher A., Kneißl F.: Computer Science for Engineers. 3rd ed. Oldenbourg (2012)
- Boswell D., Foucher T.: The Art of Readable Code (Theory in Practice), O'Reilly & Associates; Edition: 1 (2011)
- Wolf J., Krooß R.: Grundkurs C, 3rd edition, Rheinwerk Computing (2020)
- Passig, K., Jander, J.: Programming Less Badly, O'Reilly & Associates; Edition: 1 (2013)
- Kernighan B.W., Ritchie D.M.: Programming in C. ANSI C, Hanser (1990)
- Prinz P, Crawford T.: C in a Nutshell, O'Reilly & Associates; Edition: 1 (2006)

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		**TM abbreviation**
Internship Computer Science 1		**PIN1**
Person responsible	Faculty	
	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
N.N.	in each semester	
Teaching form		
Independent internship on the computer; supervision on request; partly also online; submission interviews		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	2 SWS	English	2

Time required:

On-campus study programme	Self-study
at least 1 h (delivery meetings) up to 23 h (free allocation)	Preparation and follow-up: 37-59 h (free The sufficient preparation and follow-up of the sub-module IN2 is a prerequisite.

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

In the course of the internship, students will be given independent programming tasks.
which introduce and deepen the different concepts of procedural programming.

The students are guided through the task in C implementations, whereby increasingly open questions demand independent thinking in the course of the semester and thus strengthen the ability to find solutions independently.

The following contents are touched upon:

- Basic concepts of procedural programming in C
- Structure of procedural programmes in C: definitions, declarations, instructions, expressions, functions
- Elementary data types: Declaration, definition, data types, value ranges, internal representation, literal constants, constants, arrays, structure data types
- Operators and expressions: Value and side effect, unary or binary operators, operator precedence, expressions, families of operators (bitwise, logical, arithmetic, as well as assignment or comparison operators and special operators)
- Statements and control structures: expression statements, multiple statements, branches, loops, functions and function calls
- Differentiation between expressions and instructions
- Execution model of the C language: functions, memory model, memory management, parameter mechanism, pointer
- The translation process: preprocessor, compiler, linker, multi-part programmes
- Preprocessor: preprocessor symbols, replacement mechanism, conditional compilation, include mechanism, predefined symbols
- Use of the standard library Applications of procedural programming in C
- Applications and algorithm families: state machines, sorting methods, random numbers and Monte Carlo algorithms, iterative methods, recursion, simple graphics programming, simple linked lists
- File access: Creating, reading and writing files, formatted input and output, line-by-line input and output, binary input and output
- Efficient use of the development environment
- Troubleshooting and using the debugger

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to solve programming problems independently using procedural programming.

The following knowledge (1) is acquired by the participants of the course for this purpose (10 %):

- Basic concepts and terms of the procedural programming; Knowledge of the corresponding English technical terms
- Basic language elements of C
- Knowledge of simple standard algorithms
- Basic knowledge of development tools and execution model
- Basic insight into the importance of non-functional properties (maintainability, development effort, minimal redundancy in the source code, efficient execution, economical use of hardware resources) as well as possibilities for implementation

The following skills (2) are acquired by the participants of the course (60 %):

- Implementation of existing algorithms in C
- Understanding foreign implementations
- Independent design of your own simple algorithms
- Presentation of self-developed software solutions and discussion of controversial solutions
- Independent creation of procedurally structured software designs and their correct implementation
- Dealing with development environments
- Independent use of debugging tools for troubleshooting

The following technical and non-technical competences (3) are acquired by the participants of the course for this purpose (30 %):

- Independent problem analysis and structured problem-solving thinking
- Independent solution of low to moderately complex problems by designing C programmes
- Assessment of the plausibility of programme results
- Testing, debugging and troubleshooting your own and third-party C programmes

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to assess the importance of careful, independent work and precise formulation for their learning success. Personal competences are not primarily taught explicitly in this course, but in particular interwoven with the professional competences and tested as far as possible. See therefore also under "Professional competence".
Training materials offered
Practical tasks, programme bodies, additional instructions
Teaching media
Computer (also own) with open source development environment, if necessary blackboard, beamer, eLearning course
Literature
• Böttcher A., Kneißl F.: Computer Science for Engineers. 3rd ed. Oldenbourg (2012) • Boswell D., Foucher T.: The Art of Readable Code (Theory in Practice), O'Reilly & Associates; Edition: 1 (2011) • Wolf J., Krooß R.: Grundkurs C, 3rd edition, Rheinwerk Computing (2020) • Kernighan B.W., Ritchie D.M.: Programming in C. ANSI C, Hanser (1990) • Passig, K., Jander, J.: Programming Less Badly, O'Reilly & Associates; Edition: 1 (2013) • Prinz P, Crawford T.: C in a Nutshell, O'Reilly & Associates; Edition: 1 (2006)

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Computer Science 2 (Computer Science 2)		8
Person responsible for the module	Faculty	
N.N.		

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
2	1	Compulsory	5

Recommended prior knowledge
In order to successfully complete the module, a solid basic knowledge of procedural Programming with C is a necessary prerequisite. These are usually acquired in the lecture Computer Science 1 and the corresponding practical course Computer Science 1. In addition to the passive and active mastery of the corresponding concepts of data types, operators, control structures (loops, branches) and functions (incl. parameter and return value transfer), their characteristics in C and the basics of procedural programming (e.g. parameter transfer mechanism, return values) as well as the handling of pointers and dynamic programming are taught. memory management and mastery of the simplest algorithms. In addition to knowledge and understanding of the relevant concepts, the ability to apply the concepts in practice when solving programming tasks and to use the relevant programming tools (preprocessor, compiler, IDE, debugger) of the C language is required.

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Computer science 2	2 SWS	3
2.	Internship Computer Science 2	2 SWS	2

Submodule	**TM abbreviation**
Computer science 2	**IN2**

Responsible person	Faculty
Teacher / Lecturer	**Offer frequency**
N.N.	in each semester

Teaching form
Lecture with 20% exercises

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	2 SWS	English	3

Time required:

On-campus study programme	Self-study
22 h	Preparation and follow-up: 52 h (also necessary for efficient completion of the internship); exam preparation: 16 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

Object-oriented programming and its implementation in the C++ programming language

- UML as a description language for object-oriented programme designs
- Classes and objects
- Life cycles of objects
- Inheritance and polymorphism, virtual methods
- Abstract classes and methods
- Data encapsulation / const-correctness
- Exception mechanism
- References and other new data types
- Overloading functions and operators
- Default parameters for functions
- Implementation of data structures and algorithms in C++
- The C++ standard library
  - Container data types
  - Template mechanism
  - Iterators

Basic topics of software engineering

- Problem-oriented object-orientated design of applications
- Problem-based development and implementation of basic data structures
- Problem-based development and implementation of simple algorithms
- Design and implementation concepts with recursion versus iteration

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to solve complex programming problems independently using the concepts of object-oriented programming.

The following knowledge (1) is acquired by the participants of the course for this purpose (10 %):

- Basic concepts and terms of object-oriented programming
- Basic knowledge of the mode of operation and operation of development tools
- Basic knowledge of the execution model
- In-depth knowledge of the C++ language elements
- In-depth understanding of the C++ memory model
- Basic concepts of version management in software development

The following skills (2) are acquired by the participants of the course (40 %):

- Independent implementation of existing algorithms in C++
- Independent understanding of foreign implementations in C++ based on the source code
- Independent design of simple object-orientated software solutions
- Independent use of debugging tools for troubleshooting
- Documentation (UML class diagrams, comments, documentation tools such as Doxygen)
- Presentation of self-developed software solutions and discussion of controversial solutions
- Creating object-orientated software designs and their correct implementation
- Dealing with development environments

- Using modern version management software for source code management and Collaboration
- Practical application of object orientation in programmes
- Insight into the importance of non-functional properties (maintainability, development effort, minimal redundancy in the source code) and the possibilities of implementation

The following technical and non-technical competences (3) are acquired by the participants of the course for this purpose (30 %):

- Independent problem analysis and structured problem-solving thinking
- Independently solve low to medium complexity problems by designing C ++ programmes
- Independent troubleshooting and correction of own and third-party C++ programmes
- Independent design of powerful, error-free and robust C++ programmes
- Assessment of the performance and resource consumption of programmes
- Assessment of the plausibility of programme results

Learning objectives: Personal competence

After successfully completing this sub-module, students will be able to recognise the dangers and opportunities of teamwork during their studies and use them in a targeted and optimal way. They are aware of the importance of the theoretical understanding of problems for an optimal and efficient solution.

Personal competences are not primarily taught explicitly in this course, but are interwoven with the subject-specific competences and related to the subject-specific content and tested as far as possible. See therefore also under "Professional competence".

Teaching media

Blackboard, computer with development environment, projector, supplementary documents in the associated eLearning course

Literature

- Prinz, P.; Kirch-Prinz, U.: C++ Lernen und professionell anwenden. 4th ed. MITP (2007)
- N.N.: C++ for C programmers. 12th edition, RRZN-Scripten, Hanover
- Meyers S.: Effektiv C++ programmieren. 3rd ed., Addison-Wesley (2008)
- Stroustrup B.: The C++ Programming Language. 4th ed., Addison-Wesley (2009)
- Dattatri, Kayshav: C++: Effective Object-Oriented Software Construction
- Jürgen Wolf, Basic Course C++, Galileo Computing
- Jürgen Wolf, C++ The comprehensive manual, Galileo Computing
- Free book: http://de.wikibooks.org/wiki/Datei:Cplusplus.pdf
- Stanley B. Lippman, Josée Lajoie, Barbara E. Moo: C++ Primer, Addison Wesley
- Andrew Koenig, Barbara E. Moo: Accelerated C++, Addison Wesley
- Richard M. Reese: Understanding and Using C Pointers, O'Reilly

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	TM abbreviation
Internship Computer Science 2	**PIN2**

Responsible person	Faculty
Teacher / Lecturer	**Offer frequency**
N.N.	in each semester

Teaching form
Internship at computer workstations

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	2 SWS	English	2

Time required:

On-campus study programme	Self-study
1 h (delivery interviews)	Preparation and follow-up: 59 h (at home or on site) Sufficient preparation and follow-up of the IN2 sub-module is a prerequisite.

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

As part of the course, the participants will independently
Programming tasks are solved according to various given problems. The following topics are used in practice:
 	
Object-oriented programming and its implementation in the C++ programming language
 	
• UML as a description language for object-oriented programme designs
• Classes and objects
• Life cycles of objects
• Inheritance and polymorphism, virtual methods
• Abstract classes and methods
• Data encapsulation / const-correctness
• Exception mechanism
• References and other new data types
• Overloading functions and operators
• Default parameters for functions
• Implementation of data structures and algorithms in C++
• The C++ standard library
    • Container data types
    • Template mechanism
    • Iterators
 	
Basic topics of software engineering
 	
• Problem-oriented object-orientated design of applications
• Problem-based development and implementation of basic data structures
• Problem-based development and implementation of simple algorithms
• Design and implementation concepts with recursion versus iteration

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to solve programming problems independently using object-oriented programming. **The following knowledge (1) is acquired by the participants of the course for this purpose (10 %):** • Basic knowledge of the mode of operation and operation of development tools • Basic knowledge of the execution model • Deepening knowledge of the C++ language elements • Deepening the understanding of the C++ memory model • Version management in software development **The following skills (2) are acquired by the participants of the course (40 %):** • Independent implementation of existing algorithms in C++ • Independent understanding of foreign implementations in C++ based on the source code • Independent design of simple object-orientated software solutions • Independent use of debugging tools for troubleshooting • Documentation (UML diagrams, comments, documentation tools such as Doxygen), presentation of self-developed software solutions and

- Discussion of controversial solutions
- Creating object-oriented software designs and correct implementation
- Dealing with development environments
- Use of modern version management software for source code management and collaboration
- Practical application of object orientation in programmes
- Insight into the importance of non-functional properties (maintainability, development effort, minimal redundancy in the source code) and the possibilities of implementation

The following technical and non-technical competences (3) are acquired by the participants of the course for this purpose (30 %):

- Independent problem analysis and structured problem-solving thinking
- Independent solution of low to moderately complex problems by designing C ++ programmes
- Independent troubleshooting and correction of own and third-party C++ programmes
- Independent design of powerful, error-free and robust C++ programmes
- Assessment of the performance and resource consumption of programmes
- Assessment of the plausibility of programme results

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to recognise the dangers and opportunities of teamwork in their studies and make the best possible use of them. They recognise the importance of careful and precise work and a well-considered approach when creating technical solutions. Personal competences are not primarily taught explicitly in this course, but are interwoven with the subject-specific competences and related to the subject-specific content and tested as far as possible. See therefore also under "Professional competence".

Training materials offered
Practical tasks, programme bodies, additional instructions, git quick guide and online mini tutorial

Teaching media
Computer with development environment (or open source development environment on own computer), git client, gitLab server, eLearning course, blackboard and projector if necessary

Literature

- Prinz, P.; Kirch-Prinz, U.: C++ Lernen und professionell anwenden. 4th ed. MITP (2007)
- N.N.: C++ for C programmers. 12th edition, RRZN-Scripten, Hanover
- Meyers S.: Effektiv C++ programmieren. 3rd ed., Addison-Wesley (2008)
- Stroustrup B.: The C++ Programming Language. 4th ed., Addison-Wesley (2009)
- Jürgen Wolf, Basic Course C++, Galileo Computing
- Jürgen Wolf, C++ The comprehensive manual, Galileo Computing
- Free book: http://de.wikibooks.org/wiki/Datei:Cplusplus.pdf
- Stanley B. Lippman, Josée Lajoie, Barbara E. Moo: C++ Primer, Addison Wesley
- Andrew Koenig, Barbara E. Moo: Accelerated C++, Addison Wesley
- Richard M. Reese: Understanding and Using C Pointers, O'Reilly

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track A 1 LT1A	6a

Person responsible for the module	Faculty
Lucie Eireiner (LB)	General science programme

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
1	1	Compulsory	5

Recommended prior knowledge
German language skills at A2.2 level

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track A 1 LT1A - DaF: B1.1	4 SWS	5

Submodule	**TM abbreviation**
Language Track A 1 LT1A - DaF: B1.1	**LT1A**

Person responsible	Faculty
Lucie Eireiner (LB)	General science programme
Teacher / Lecturer	Offer frequency
N.N.	in each semester
Teaching form	
Seminar-based teaching	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
Written exam 90 minutes
Authorised aids for proof of performance
none

Contents
In this course, students learn at an advanced level and are able to discuss familiar communicate about familiar topics from the fields university, work, leisure time. (In this course, students learn on an advanced level and can communicate about familiar topics from the fields university, work, leisure time).
Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- use passive with and without modal verb (3)
- form conditional, concessive, final and generalising relative clauses (3)
- use the 3)
- Partizip I und II als Adjektiv zu verwenden (use participle I and II as adjectives) (3)
- Use prepositional pronouns 3)
- use new vocabulary from different subject areas (mobility, freetime, sightseeing, relationships, study, voluntary work, work etc.) (3)
- present the own opinion 2)
- give a report 2)

- discuss advantages and disadvantages (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • write argumentatively 2) • Express purpose and conditions (3) • Understand announcements on the radio 2) • write in a forum and express their opinions (3) • exchange experiences (share experiences) (2) • hold a presentation 2)
Teaching media
Interactive course book, additional exercises as copies or in ELO, videos, online additional material (Course and exercise book, additional exercises on handouts or in ELO)
Literature
Course and exercise book "Kurs DaF B1" Course and exercise book with audios and videos; ISBN 978-3-12-676842-9 (Klett-Verlag) Course DaF B1 - Hybrid Edition allango: Course and exercise book with audios and videos including licence key allango (24 months) | Klett Sprachen Students have to buy the book themselves!

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track A 2 LT2A	12a

Person responsible for the module	Faculty
Lucie Eireiner (LB)	General science programme

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
2	1	Compulsory	5

Recommended prior knowledge
German language skills at B1.1 level

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track A 2 LT2A - DaF: B1.2	4 SWS	5

Submodule	**TM abbreviation**
Language Track A 2 LT2A - DaF: B1.2	**LT2A**

Responsible person	Faculty
Lucie Eireiner (LB)	General science programme
Teacher / Lecturer	Offer frequency
N.N.	in each semester
Teaching form	
Seminar-based teaching	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
Written exam 90 minutes
Authorised aids for proof of performance
none

Contents
In this course, students learn at an advanced level and master topics that personal areas of interest. You can also deal with communication situations that you encounter when travelling in German-speaking countries or at work. You understand the main points when it comes to familiar topics. (In this course, students learn at an advanced level and master topics related to their personal areas of interest. They can also cope with communication situations encountered when travelling in German-speaking countries or at work. They understand the main points when dealing with familiar topics).
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • to use the past perfect tense (3) • form sentences with twin connectors 3) • form infinitive and relative clauses 3) • make prognosis for the future 2) • talk about different forms of greetings. Greetings (talk about different forms of greetings) (2) • understand an employment contract 2) • to discuss and to convey arguments 2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • summarise a newspaper article in writing (summarize a newspaper article) (2) • write about their dreams for the future (2) • speak about their future 2) • talk about experiences 3) • introduce themselves on their first day at work (3)talk about political engagement (3) • Varietäten der deutschen Sprache zu unterscheiden (to distinguish varieties of German) (2)
Teaching media
Interactive course book, additional exercises as copies or in ELO, videos, online additional material (Course and exercise book, additional exercises on handouts or in ELO)
Literature
Course and exercise book "Kurs DaF B1" Course and exercise book with audios and videos; ISBN 978-3-12-676842-9 (Klett-Verlag) Course DaF B1 - Hybrid edition allango: Course and exercise book with audios and videos including licence key allango (24 months) | Klett Sprachen Students have to buy the book themselves!

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Language Track A 3 LT3A		17a
Person responsible for the module	Faculty	
Lucie Eireiner (LB)	General science programme	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
3	1	Compulsory	6

Recommended prior knowledge
German language skills at B1 level

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track A 3 LT3A - DaF: B2.1	6 SWS	6

Submodule	TM abbreviation
Language Track A 3 LT3A - DaF: B2.1	**LT3A**

Responsible person	Faculty
Lucie Eireiner (LB)	General science programme
Teacher / Lecturer	Offer frequency
N.N.	in each semester
Teaching form	
Seminar-based teaching	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
3	6 SWS	German	6

Time required:

On-campus study programme	Self-study
90 h	90 h

Study and examination performance
Written exam 90 minutes
Authorised aids for proof of performance
none

Contents
In this course, participants with a solid B1 level of German deepen their knowledge of German to B2 level. With the textbook, they specifically train their language skills in the areas of speaking, listening, reading and writing - always in the context of current and relevant topics. The focus is on key areas of society such as the world of work and career, culture and leisure, media and communication as well as science and the environment. This not only expands vocabulary, but also develops the ability to express one's own points of view in a differentiated and precise manner - both orally and in writing. In this course, participants with solid B1-level skills deepen their German language proficiency to B2 level. Using the textbook, they specifically train their language skills in speaking, listening, reading, and writing-always in the context of current and relevant topics. The focus is on key societal areas such as the world of work and profession, culture and leisure, media and communication, as well as science and the environment. In addition to expanding vocabulary, the course also develops the ability to express personal viewpoints in a differentiated and precise manner-both orally and in writing.

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • actively participate in conversations, discussions and debates (3) • formulate arguments clearly and express their own opinions in a differentiated manner (2) • write structured texts such as e-mails, reports, letters of application and statements (2) • Write summaries and arguments (3) • understand and analyse complex texts from the media, professional and scientific fields (3) • identify main and secondary information, argumentation structures and text intentions (3) • understand authentic audio texts (interviews, lectures, news) (2) • use complex grammatical structures (e.g. subjunctive II, passive voice, nominal style) (3) • Vocabulary on topics Working world, media use, mobility, intercultural communication (3) • Actively participating in conversations, discussions, and debates (3) • Clearly formulating arguments and expressing personal opinions in a differentiated manner (2) • Writing structured texts such as emails, reports, cover letters, and statements (2) • Writing summaries and arguments (3) • Understanding and analysing complex texts from the fields of media, profession, and science (3) • Identifying main and supporting information, argumentation structures, and text intentions (3) • Understanding authentic listening texts (interviews, lectures, news) (2) • Using complex grammatical structures (e.g., subjunctive II, passive, nominal style) (3) • Mastering vocabulary on topics such as the world of work, media usage, mobility, and intercultural communication (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • work on/present complex tasks independently (3) • make differentiated and structured contributions to discussions (2) • Deepen understanding of different communication styles and behaviour patterns (2) • work effectively in partners and groups (3) • scrutinise and reflect on opinions and information (2) • justify/represent own points of view in discussions (3) • give clearly structured lectures and presentations on more complex topics (3) • Formulate ideas precisely and convincingly in writing and orally (3)<>- Independently working on/presenting complex tasks (3) • Contributing differentiated and structured input in discussions (2) • Deepening understanding of different communication styles and behavioural patterns (2)

- Working effectively in partner and group work (3)
- Questioning opinions and information and reflecting critically on them (2)
- Justifying/representing personal viewpoints in discussions (3)
- Delivering well-structured presentations on more complex topics (3)
- Formulating ideas clearly and persuasively, both in writing and speaking (3)

Teaching media
Projector, blackboard, audios, interactive exercises, ELO
Literature
tba

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track B 1 LT1B	6b

Person responsible for the module	Faculty
Prof Dr Gabriele Blod	Applied natural and cultural sciences
Ulrike de Ponte	Applied natural and cultural sciences
Prof Dr Katherine Gürtler	Applied natural and cultural sciences
Prof Dr Thomas Kriza	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
1	1	Compulsory	5

Assigned sub-modules:

No.	Designation of the sub-modules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track B 1 LT1B	4 SWS	5

Notes on compulsory occupancy or options
Students in Language Track B can choose from different modules of the AW programme and the language programme offered by the Faculty of Applied Sciences and Cultural Studies in order to obtain the required ECTS per Language Track B module. Within the AW programme, only lectures with an international or intercultural reference can be chosen. For LT3-4, in addition to the AW programme and the language track, students can also choose lectures from the "International Handlungskompetenzen" programme offered by the Faculty of Applied Natural Sciences and Cultural Studies. Two of the language track B modules should cover two consecutive language modules of the same language, in order to guarantee a profound knowledge of at least one language other than the mother tongue. If the chosen courses do not provide at least the number of ECTS required for LT1-5B, several courses must be combined.

Submodule	TM abbreviation
Language Track B 1 LT1B	**LT1B**

Person responsible	Faculty
Prof Dr Gabriele Blod Ulrike de Ponte Prof. Dr Katherine Gürtler Prof. Dr Thomas Kriza	Applied natural and cultural sciences
Teacher / Lecturer	Offer frequency
N.N.	in each semester
Teaching form	
lecture-specific	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	4 SWS		5

Time required:

On-campus study programme	Self-study
lecture-specific	lecture-specific

Study and examination performance
see "Study plan table"
Authorised aids for proof of performance
see "Study plan table"

Contents
lecture-specific
Learning objectives: Professional competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Learning objectives: Personal competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Training materials offered
lecture-specific
Teaching media
lecture-specific

Literature
lecture-specific
Further information on the course
Responsible for AW-programme: Prof. Dr Gabriele Blod and in future Prof. Dr Kriza Responsible for language-programme: Prof. Dr Katherine Gürtler Responsible for "International Competence": Ulrike de Ponte

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track B 2 LT2B	12b

Person responsible for the module	Faculty
Prof Dr Gabriele Blod	Applied natural and cultural sciences
Ulrike de Ponte	Applied natural and cultural sciences
Prof Dr Katherine Gürtler	Applied natural and cultural sciences
Prof Dr Thomas Kriza	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
2	1	Compulsory	5

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track B 2 LT2B	4 SWS	5

Notes on compulsory occupancy or options
Students in Language Track B can choose from different modules of the AW programme and the language programme offered by the Faculty of Applied Sciences and Cultural Studies in order to obtain the required ECTS per Language Track B module. Within the AW programme, only lectures with an international or intercultural reference can be chosen. For LT3-4, in addition to the AW programme and the language track, students can also choose lectures from the "International Handlungskompetenzen" programme offered by the Faculty of Applied Natural Sciences and Cultural Studies. Two of the language track B modules should cover two consecutive language modules of the same language, in order to guarantee a profound knowledge of at least one language other than the mother tongue. If the chosen courses do not provide at least the number of ECTS required for LT1-5B, several courses must be combined.

Submodule	TM abbreviation
Language Track B 2 LT2B	**LT2B**

Person responsible	Faculty
Prof Dr Gabriele Blod Ulrike de Ponte Prof. Dr Katherine Gürtler Prof. Dr Thomas Kriza	Applied natural and cultural sciences
Teacher / Lecturer	**Offer frequency**
N.N.	in each semester

Teaching form
lecture-specific

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	4 SWS		5

Time required:

On-campus study programme	Self-study
lecture-specific	lecture-specific

Study and examination performance
see "Study plan table"
Authorised aids for proof of performance
see "Study plan table"

Contents
lecture-specific
Learning objectives: Professional competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Learning objectives: Personal competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Training materials offered
lecture-specific
Teaching media
lecture-specific

Literature
lecture-specific
Further information on the course
Responsible for AW-programme: Prof. Dr Gabriele Blod and in future Prof. Dr Kriza Responsible for language-programme: Prof. Dr Katherine Gürtler Responsible for "International Competence": Ulrike de Ponte

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track B 3 LT3B	17b

Person responsible for the module	Faculty
Prof Dr Gabriele Blod	Applied natural and cultural sciences
Ulrike de Ponte	Applied natural and cultural sciences
Prof Dr Katherine Gürtler	Applied natural and cultural sciences
Prof Dr Thomas Kriza	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
3	1	Compulsory	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track B 3 LT3B	4 SWS	5

Notes on compulsory occupancy or options
Students in Language Track B can choose from different modules of the AW programme and the language programme offered by the Faculty of Applied Sciences and Cultural Studies in order to obtain the required ECTS per Language Track B module. Within the AW programme, only lectures with an international or intercultural reference can be chosen. For LT3-4, in addition to the AW programme and the language track, students can also choose lectures from the "International Handlungskompetenzen" programme offered by the Faculty of Applied Natural Sciences and Cultural Studies. Two of the language track B modules should cover two consecutive language modules of the same language, in order to guarantee a profound knowledge of at least one language other than the mother tongue. If the chosen courses do not provide at least the number of ECTS required for LT1-5B, several courses must be combined.

Submodule			TM abbreviation
Language Track B 3 LT3B			**LT3B**
Responsible person	Faculty		
Prof Dr Gabriele Blod Ulrike de Ponte Prof. Dr Katherine Gürtler Prof. Dr Thomas Kriza	Applied natural and cultural sciences		
Teacher / Lecturer	Offer frequency		
N.N.	in each semester		
Teaching form			
lecture-specific			

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
3	4 SWS		5

Time required:

On-campus study programme	Self-study
lecture-specific	lecture-specific

Study and examination performance
see "Study plan table"
Authorised aids for proof of performance
see "Study plan table"

Contents
lecture-specific
Learning objectives: Professional competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Learning objectives: Personal competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Training materials offered
lecture-specific
Teaching media
lecture-specific

Literature
lecture-specific
Further information on the course
Responsible for AW-programme: Prof. Dr Gabriele Blod and in future Prof. Dr Kriza Responsible for language-programme: Prof. Dr Katherine Gürtler Responsible for "International Competence": Ulrike de Ponte

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Mathematics 1 (Mathematics 1)		1
Person responsible for the module	Faculty	
Prof Dr Wolfgang Lauf	Computer science and maths	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
1	1	Compulsory	6

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Mathematics 1	6 SWS	6

Submodule	TM abbreviation
Mathematics 1	**MA1**

Responsible person	Faculty
Prof Dr Wolfgang Lauf	Computer science and maths
Teacher / Lecturer	**Offer frequency**
Dr Gerhard Dietel (LB) Prof. Dr Michael Fröhlich Dr Detlef Gröger (LB) Prof. Dr Georg Illies Prof. Dr Wolfgang Lauf Prof Dr Dietwald Schuster	in each semester

Teaching form
Seminar-based teaching: approx. 20 % exercise component

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	6 SWS	English	6

Time required:

On-campus study programme	Self-study
84 h	Preparation and follow-up: 67 h Exam preparation: 29 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Basics Sets, sequences, series, functions - One-dimensional differential calculus Derivation of elementary functions Differentiation rules Curve discussion - One-dimensional integral calculus Surface area and definite integral Basis function and indefinite integral Integration methods Improper integrals - Real vector spaces Vector concept Linear correlations Amount, distance, scalar product, vector product - Matrices and determinants Matrix arithmetic Quadratic matrices Rank, determinant Eigenvalues and eigenvectors - Linear systems of equations Line level form Solution space

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • explain basic concepts, definitions and examples of univariate real analysis, e.g. limit, sequence, derivative, integral, and linear algebra, e.g. vector, matrix, linear system of equations (1); • give an overview of essential rules and methods of univariate real analysis, e.g. of differentiation, integration, and of linear algebra, e.g. matrix calculation, determinant and eigenvalue calculation, for solving linear systems of equations (1); • Convergence / divergence of simple real number sequences (2); • to reliably determine the derivative of univariate real functions (2); • correctly use important integration methods for univariate real functions (2); • perform matrix, rank and determinant calculations correctly (2); • eigenvalues and eigenvectors in small dimensions (2); • safely calculate the solution spaces of linear systems of equations (2); • to investigate the limit value and continuity behaviour of univariate real functions (3); • analyse the behaviour of univariate real functions by using differential calculus (3); • use integral calculus to analyse univariate real functions geometrically (3);

• use the matrix calculus and matrix parameters for linear relationships in a targeted manner to be used (3); • analyse and interpret solution spaces of linear systems of equations (3).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, bibliography
Teaching media
Overhead projector, blackboard, computer, projector, mathematical software
Literature
Stewart, J.: Calculus, Cengage Learning Services, 2014 Strang, G.: Linear Algebra, Springer, 1998 Stry, Y., Schwenkert, R.: Mathematik kompakt, Springer, 2012 Westermann, Th.: Mathematik für Ingenieure, Springer, 2011

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Mathematics 2 (Mathematics 2)		7
Person responsible for the module	Faculty	
Prof Dr Wolfgang Lauf	Computer science and maths	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
2	1	Compulsory	6

Mandatory requirements
None
Recommended prior knowledge
Mathematics 1

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Mathematics 2	6 SWS	6

Submodule		TM abbreviation
Mathematics 2		**MA2**
Person responsible	Faculty	
Prof Dr Wolfgang Lauf	Computer science and maths	
Teacher / Lecturer	Offer frequency	
Dr Gerhard Dietel (LB) Prof. Dr Michael Fröhlich Dr Detlef Gröger (LB) Prof. Dr Georg Illies Prof. Dr Wolfgang Lauf Prof Dr Dietwald Schuster	in each semester	
Teaching form		
Seminar-based teaching: approx. 20 % exercise component		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	6 SWS	English	6

Time required:

On-campus study programme	Self-study
84 h	Preparation and follow-up: 67 h Exam preparation: 29 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Complex numbers Normal, polar and exponential form Arithmetic Geometric interpretation - Power series Convergence behaviour Methods of power series development - Complex functions Definition and geometric interpretation Exponential function and related functions Logarithm and general power - Differential and integral calculus of several variable functions with several variables Partial differentiation and total differential Applications Local and global extreme values Multiple integrals - Ordinary differential equations Initial value and boundary value problems 1st order differential equations Numerical solution methods Linear differential equations of 2nd order with constant coefficients Differential equations of higher order Differential equation systems

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • explain basic concepts, definitions and examples of complex analysis, e.g. power series, elementary functions, multivariate real analysis, e.g. derivatives, multiple integral, and ordinary differential equations, e.g. classification (1); • correctly apply important convergence criteria to simple number series (2); • correctly determine the convergence regions of simple power series (2); • calculate safely with complex numbers and elementary complex functions (2); • visualise complex numbers and elementary complex functions geometrically (2); • calculate partial and total derivatives of multivariate real functions (2); • correctly perform important integration methods for multivariate real functions (2); • to investigate the limit value and continuity behaviour of multivariate real functions (3); • analyse the behaviour of multivariate real functions (including extreme values) by differential calculus (3); • to analyse multivariate functions geometrically with multiple integration (3); • correctly apply important solution methods to simple ordinary differential equations (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, bibliography
Teaching media
Overhead projector, blackboard, computer, projector, mathematical software
Literature
Stewart, J.: Calculus, Cengage Learning Services, 2014 Stry, Y., Schwenkert, R.: Mathematik kompakt, Springer, 2012 Westermann, Th.: Mathematik für Ingenieure, Springer, 2011

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Mathematics 3 (Mathematics 3)		13
Person responsible for the module	Faculty	
Prof Dr Wolfgang Lauf	Computer science and maths	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
3	1	Compulsory	5

Recommended prior knowledge
Mathematics 1,2

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Maths 3	4 SWS	5

Submodule	**TM abbreviation**
Maths 3	**MA3**

Person responsible	Faculty
Prof Dr Wolfgang Lauf	Computer science and maths
Teacher / Lecturer	**Offer frequency**
Prof Dr Jonny Dambrowski Dr Gerhard Dietel (LB) Prof. Dr Schuster Dietwald Prof. Dr Michael Fröhlich Dr Detlef Gröger (LB) Prof. Dr Georg Illies Prof Dr Wolfgang Lauf	in each semester

Teaching form
Seminar-based teaching: approx. 20 % exercise component

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
3	4 SWS	English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 65 h, Exam preparation: 29 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Fourier series: oscillations and periodic functions, Fourier analysis • Fourier transform: Fourier integral, Fourier transform, Discrete Fourier transform • Laplace transform: Laplace transform, inverse Laplace transforms, transformation rules, application to differential equations • Fundamentals of vector analysis: scalar and vector fields, gradient, divergence and rotation, curve integrals, surface integrals
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • explain basic concepts, definitions and examples of Fourier analysis, Fourier and Laplace transforms and vector analysis (1);

- Fourier series, Fourier integral and discrete Fourier transform for simple functions to determine (2);
- use the transformation rules for the Laplace transformation safely (2);
- correctly calculate important variables of vector analysis (2);
- to use the Fourier and Laplace transforms for problem transplantation from the time to the spectral domain (3);
- the Laplace transformation for the solution linear differential equations with confidence (3);
- analyse simple networks using Laplace transformation (3);
- interpret important variables of vector analysis in an application-oriented way (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, bibliography
Teaching media
Overhead projector, blackboard, computer, projector, mathematical software
Literature
Meyberg, Vachenauer: Advanced Mathematics 2, 2005 Stewart, J.: Calculus, Cengage Learning Services, 2015 Weber, H.: Laplacetransformation, Teubner, 2007 Westermann, Th.: Mathematik für Ingenieure, Springer, 2011

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Physics (Physics)	4

Person responsible for the module	Faculty
Prof Dr Christoph Höller	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
1	1	Compulsory	5

Mandatory requirements
None
Recommended prior knowledge
Integral and differential calculus, vector calculus, physics at school-leaving certificate level, Maths at school-leaving certificate level

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Physics	4 SWS	5

Submodule	TM abbreviation
Physics	**PH**

Responsible person	Faculty
Prof Dr Christoph Höller	Applied natural and cultural sciences
Teacher / Lecturer	**Offer frequency**
Prof Dr Christoph Höller Prof. Dr Friedhelm Kuypers Prof. Dr Johannes Wild	in each semester

Teaching form
Seminar-based teaching with 15% exercises Supplementary practical course in physics in the 2nd semester

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
1	4 SWS	English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Kinematics: linear motion, circular motion • Dynamics: Newton's axioms, forces, friction • Conservation laws: Energy, momentum • Vibrations: Free oscillation, forced oscillation, resonance • Waves: Wave function, interference, standing waves, diffraction • Fundamentals of optics: refraction, dispersion • Practical applications
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know basic physical relationships in the field of classical mechanics and wave theory (1). • set up equations for simple physical problems in mechanics and wave theory (2) and solve them (2). • establish the connection between practical applications and the underlying physical relationships (3).

- Understand physical problems in mechanics and wave theory (3), select appropriate solutions (2) and interpret the solution (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Collection of tasks
Teaching media
Blackboard, projector, experiments
Literature
F. Kuypers: Physics for Engineers and Scientists, Volume 1, 3rd edition, 2012, Wiley-VCH Publishing House F. Kuypers: Physics for Engineers and Scientists, Volume 2, 3rd edition, 2012, Wiley- VCH Verlag Halliday et al: Halliday Physics. 3rd edition, 2017, Wiley-VCH Verlag Stroppe: Physics for students of natural sciences and engineering, 16th edition, 2018, Carl Hanser Verlag

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Technical Mechanics (Mechanical Engineering)		10
Person responsible for the module	Faculty	
Prof Dr Andreas Voigt	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
2	1	Compulsory	5

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Technical Mechanics (Mechanical Engineering)	4 SWS	5

Submodule		TM abbreviation
Technical Mechanics (Mechanical Engineering)		**TM**
Responsible person	Faculty	
Prof Dr Andreas Voigt	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Armin Merten Prof Dr Andreas Voigt	in each semester	
Teaching form		
Seminar-based teaching, exercises (approx. 25%-30% exercises)		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	4 SWS	English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Stereostatics: o Basic concepts, fundamental axioms and principles, cutting principle. o Force systems on rigid bodies, centre of force, centre of gravity. o Balance. o Support and joint reactions of plane structures. o Cutting reactions in ropes, bars, beams, frames and arches. o Coulomb friction. • Elastostatics: o Stresses, deformations, distortions, Hooke's law of materials. o Stresses and deformations under tension-compression loading. o Thermal expansion and thermal stress. o Stresses and deformations in straight bending, shear and torsion of straight components. o Statically indeterminate systems. o Stress superposition, comparative stress and strength hypotheses. • Kinematics: o linear and general movement of a point. o General movement of the rigid body o Coupled motion of rigid body systems, constraints. • Kinetics: o dynamic basic law. o Momentum theorem, swirl theorem, work theorem and energy theorem for the centre of mass. o Rotation of the rigid body, moments of inertia. o Momentum theorem, swirl theorem, work theorem and energy theorem for the rigid body. o d'Alembert's principle. o Introduction to mechanical vibrations.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • explain the basic principles of stereo- and elastostatics, the movement of mass points and rigid bodies (1) • indicate the range of validity of the solutions developed, defined by assumptions and preconditions (2) • form simple static substitute models and determine unknown variables (e.g. bearing and cutting reactions) with the help of the equilibrium conditions. (2) • dimension simple, statically loaded structures with regard to deformation and strength (2) • deal with dynamic problems by formulating and solving the basic kinematic and kinetic equations (2) • solve simple mechanical tasks independently (3) • understand, evaluate and discuss complex mechanical tasks (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Lecture notes, exercises, bibliography
Teaching media
Blackboard, overhead, projector, simple visual aids
Literature
Hahn: Technical Mechanics, Hanser-Verlag, 1993 Gross, Hauger, Schröder, Wall: Engineering Mechanics, Springer-Verlag, 2013 Holzmann, Mayer, Schumpich: Engineering Mechanics, Springer-Verlag, 2014

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Materials Science		11
Person responsible for the module	Faculty	
Prof Dr Andreas Voigt	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
2	1	Compulsory	5

Recommended prior knowledge
Physics

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Practical course in physics	2 SWS	2
2.	Materials engineering	3 SWS	3

Submodule	TM abbreviation
Practical course in physics	**PPH**

Person responsible	Faculty
Prof Dr Andreas Voigt	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Peter Bickel Rita Elrod	in each semester

Teaching form
Laboratory internship

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	2 SWS	English	2

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 16 h Test analyses: 16 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Carrying out phys. Experiments and measurements • Use of oscilloscope and other laboratory equipment • Evaluation of measurement series, error estimation, statistics • Graphical representation of measurement series with Excel • Oscillations, standing waves, resonance, coupled oscillations • Fourier analysis and synthesis with harmonic generator and oscilloscope • Interference at the optical grating • Fundamentals of geometrical optics, speed of light • Waves using the example of signal transport in coaxial cables • Properties of microwaves • Interferometer according to Michelsen • Solar cell
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • simple experiments independently carry out and analyse the analyse the experimental results (3) • Measurement results can be traced back to the physical principles (3) • use suitable evaluation software correctly (2)

- error estimation, error calculation and statistical methods. (2)
- clearly formulate and evaluate test results (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • to work in the test team (2) • substantiate measurement results (3) • Clear distinction between own and external measurement results (3) • Critical reflection on the test results (3)
Training materials offered
Practical instructions, in-depth information on experiments and error calculation
Teaching media
Physical experimental set-ups
Literature
F. Kuypers: Physics for Engineers and Scientists, Vol. 1 and Vol. 2, Viley-Vch, 2012 Hering, Martin, Stohrer: Physics for Engineers, Springer, 2012 Wilhelm Walcher, "Praktikum der Physik", Springer Vieweg, 2006

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		TM abbreviation
Materials engineering		**WT**
Person responsible	Faculty	
Prof Dr Andreas Voigt	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Andreas Voigt	in each semester	
Teaching form		
Seminar-based teaching, exercises (approx. 25% - 30% exercises)		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
2	3 SWS	English	3

Time required:

On-campus study programme	Self-study
42 h	Preparation and follow-up: 20 h Exam preparation: 28 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Material structures: o Atomic structure according to Bohr-Sommerfeld. o crystalline structures and their description. o Grid construction errors and their effects. o homogeneous and heterogeneous structure, phases. o Alloys, state diagrams. o Description of amorphous structures. • Material properties: o Mechanical properties. o Electrical properties. o Magnetic properties. o thermal properties. o optical properties. • Materials in electrical engineering: o Conductor, resistor and contact materials. o Semiconductor materials. o Dielectrics. o magn. materials. o optical materials.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • describe the basic material structure (1) and explain its relationship with material properties and functional mechanisms (2). • the possibilities and limits in the optimisation and utilisation of material properties under technical boundary conditions (2). • name the various materials used in electrical engineering and their further development (1) • Formulate material requirements using the relevant parameters and their limits (2) and to evaluate (3). • Select materials appropriately for the application (3). • explain (2), evaluate (3) and discuss (3) material-based effects and functions of electrical engineering components.
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Lecture notes, bibliography
Teaching media
Blackboard, overhead, projector, visual aids

Literature
Fischer, Hofmann, Spindler: Werkstoffe in der Elektrotechnik, Hanser, 2007 Ivers-Tiffée, von Münch: Werkstoffe der Elektrotechnik, Teubner, 2007

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Analogue Circuit Design (Analogue Circuit Technology)		21
Person responsible for the module	Faculty	
Prof Dr Christian Schimpfle	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
4	2	Compulsory	5

Mandatory requirements
Basic technical studies
Recommended prior knowledge
Fundamentals of electrical engineering, electronic components, Laplace transformation

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Analogue circuit technology	4 SWS	5

Submodule		TM abbreviation
Analogue circuit technology		**SC**
Person responsible	Faculty	
Prof Dr Christian Schimpfle	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Christian Schimpfle	in each semester	
Teaching form		
Seminar-style teaching with exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
4	4 SWS	English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up of lessons: 62 h, Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

1. Basics
   - Linear and time-invariant systems, 4 basic axioms of signal processing
   - Representation of electrical quantities, Bode diagrams
   - Circuit analysis: techniques and tools
   - Linear superposition in linear networks
   - Basic principles of reinforcement
   - Miller effect
   - Switched capacities

2. Circuits with individual semiconductor components

   - Field-effect transistor (FET) in S-, G-, D-circuit and bipolar junction transistor (BJT) in E-, B-, C-circuit
   - Transistor as a switch
   - Coupling of amplifier stages: capacitive, inductive, galvanic
   - Classification of amplifier stages: A, B, C, D, AB and AC amplifiers

3. Design of amplifier circuits

   - Qualitative understanding of an integrated amplifier with an output consisting of a differential input stage, intermediate amplifier stage and output stage,
   - Qualitative understanding of the design of fully differential, integrated amplifiers

4. Circuits with operational amplifiers

   - Use of comparators and generation of hysteresis
   - Use of ideal operational amplifiers,
   - Design and use of instrumentation amplifiers,
   - Non-idealities of real operational amplifiers, reading data sheets

5. Linear feedback and error suppression

   - Basic principle of linear feedback
   - Error suppression through feedback
   - Signal and noise transfer function

6. Macro models

   - Controlled sources as abstracted assemblies of analogue circuit technology

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to
- select and apply basic components of electronic circuits (3)
- analyse linear and non-linear circuits (3)
- Recognise two-port transfer functions and associated frequency responses (1)
- Use diodes, bipolar transistors, MOSFETs as switches (3)
- Use simple logic circuits at transistor level (3)
- recognise and calculate basic circuits with bipolar transistors (3)
- recognise and calculate basic circuits with field-effect transistors (3)

- read and understand amplifier cut-off frequencies from data sheets (2)
- Understanding differential amplifiers (2)
- Power amplifiers and power amplifiers, push-pull amplifiers (2)
- Know and understand multilevel amplification principles (2)
- Design and characteristics of operational amplifiers, application of macro models (3)
- Build circuits with operational amplifiers (3)
- apply general analysis methods to calculate the properties of analogue circuits (3)
- dimension analogue circuits (3)
- identify and understand familiarised basic circuits in more complex circuits (2)
- assess the basic circuits they have learnt with regard to their suitability for various analogue signal processing applications (2)
- independently design simple circuits for various analogue signal processing functions (3)
- Independently analyse given tasks and develop creative solutions based on the knowledge acquired (3)
- analyse, compare, evaluate and assess different solution approaches and, based on this, the selection of the most suitable circuit and its implementation. (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, former exams, bibliography
Teaching media
Blackboard, laptop, projector
Literature
[1] U. Tietze, Ch. Schenk: Halbleiterschaltungstechnik, Springer-Verlag, 2012. [2] P. R. Gray, R. G. Meyer: Analysis and Design of Analogue Integrated Circuits, 3rd Edition, John Wiley & Sons, Inc., 1993. [3] P. E. Allen, D. R. Holberg: CMOS Analogue Circuit Design, Rinehart and Winston, Inc., 1987.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
AW module EI (Mandatory general studies elective module)	30

Person responsible for the module	Faculty
Prof Dr Gabriele Blod	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
6	2	Compulsory	6

Mandatory requirements
Generally none (exception e.g. higher language courses or subjects of consecutive additional training programmes)
Recommended prior knowledge
Generally none (exception e.g. higher language courses or subjects of consecutive additional training programmes)

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	AW compartment 1	2 SWS	2
2.	AW compartment 2	2 SWS	2
3.	AW compartment 3	2 SWS	2

Notes on compulsory occupancy or options
The courses in this module can be freely selected from the following range General science elective modules (AW modules) at OTH Regensburg. The module descriptions for the AW modules can be found here: https://www.oth-regensburg.de/fakultaeten/angewandte-natur-und-kulturwissenschaften/ studiengaenge/aw-module-und-zusatzausbildungen/aw-modulkatalog.html

Submodule	TM abbreviation
AW compartment 1	**AW1**

Person responsible	Faculty
Prof Dr Gabriele Blod	Applied natural and cultural sciences
Teacher / Lecturer	Offer frequency
N.N.	in each semester
Teaching form	
Seminar-based teaching, exercises, practical training	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
6	2 SWS		2

Time required:

On-campus study programme	Self-study
28 h	Depending on the course

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
depending on the course
Learning objectives: Professional competence
After successfully completing the sub-module, students are able to Depending on the course
Learning objectives: Personal competence
After successfully completing the sub-module, students are able, depending on the course, to
Training materials offered
depending on the course
Teaching media
Depending on the course

Literature
Depending on the course
Further information about the course
Responsible for the AW programme: Prof. Dr Gabriele Blod, in future Prof. Dr Thomas Kriza Responsible for the language programme: Prof. Dr Katherine Gürtler

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		TM abbreviation
AW compartment 2		**AW2**
Responsible person	Faculty	
Prof Dr Gabriele Blod	Applied natural and cultural sciences	
Teacher / Lecturer	Offer frequency	
N.N.	in each semester	
Teaching form		
Depending on the course		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
6	2 SWS		2

Time required:

On-campus study programme	Self-study
28 h	Depending on the course

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
depending on the course
Learning objectives: Professional competence
After successfully completing the sub-module, students are able to Depending on the course
Learning objectives: Personal competence
After successfully completing the sub-module, students are able to Depending on the course
Training materials offered
Depending on the course
Teaching media
Depending on the course

Literature
Depending on the course
Further information on the course
Responsible for the AW programme: Prof. Dr Gabriele Blod, in future Prof. Dr Thomas Kriza Responsible for the language programme: Prof. Dr Katherine Gürtler

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		TM abbreviation
AW compartment 3		**AW3**
Responsible person	Faculty	
Prof Dr Gabriele Blod	Applied natural and cultural sciences	
Teacher / Lecturer	Offer frequency	
N.N.	in each semester	
Teaching form		
Depending on the course		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
6	2 SWS		2

Time required:

On-campus study programme	Self-study
28 h	Depending on the course

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Depending on the course
Learning objectives: Professional competence
After successfully completing the sub-module, students are able to Depending on the course
Learning objectives: Personal competence
After successfully completing the sub-module, students are able to Depending on the course
Training materials offered
Depending on the course
Teaching media
Depending on the course
Literature
Depending on the course

Further information on the course
Responsible for the AW programme: Prof. Dr Gabriele Blod, in future Prof. Dr Thomas Kriza Responsible for the language programme: Prof. Dr Katherine Gürtler

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Electrical Energy Converters and Systems Engineering (Electrical Energy Conversion and System Technology)		24
Person responsible for the module	Faculty	
Prof Dr Franz Fuchs	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
5	2	Compulsory	6

Recommended prior knowledge
For Electrical Energy Converters: Fundamentals of Electrical Engineering

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Electrical systems engineering	4 SWS	4
2.	Electrical energy converters	2 SWS	2

Submodule		TM abbreviation
Electrical systems engineering		**EA**
Person responsible	Faculty	
Prof Dr Franz Fuchs	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Franz Fuchs	in each semester	
Teaching form		
Seminar-based teaching: 10-15% exercise component		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	4 SWS	German/English	4

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 25 h Exam preparation: 39 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Electricity demand and demand coverage - Design and structure of electrical energy networks - Electrical power supply equipment - Theoretical principles, function, structure, equivalent circuit diagrams, operating parameters and designs of • Power transformers • Overhead lines • Power cable • Switchgear and switchgear systems
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know the terms and equipment of electrical energy networks (1) • the special features of three-phase systems and the structure and operation of electrical power supply networks (2) • know the principles of operation, technical designs and operating parameters of electrical power network equipment (2) • the parameters influencing the electrical system energy network (2) • understand and analyse circuits in systems engineering (3)

- Operating parameters and equivalent circuit diagrams for the equipment the electrical Determine energy supply (3)
- apply the equivalent circuit diagrams of the systems of the electrical energy networks and thus calculate the voltages and currents or active and reactive powers required for their operation (3)
- plan the basic outline of electrical systems (3)

Learning objectives: Personal competence
After successfully completing the sub-module, students are able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Bibliography, gap-fill slides, exercises
Teaching media
Blackboard, computer/beamer
Literature
Noack F.: Einführung in die elektrische Energietechnik, Fachbuchverlag, Leipzig, 2003 Flossdorf, Hilgarth: Electrical power distribution, Vieweg+Teubner, 2005 Knies W., Schierack K., Berger M.: Elektrische Anlagentechnik - Kraftwerke, Netze, Schaltanlagen, Schutzeinrichtungen, Carl Hanser Verlag, 7th revised edition, 2021

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	**TM abbreviation**
Electrical energy converters	**EW**

Responsible person	Faculty
Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Bernhard Hopfensperger	in each semester
Teaching form	
Seminar-based teaching with approx. 15% exercises	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	2 SWS	German/English	2

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 20 h Exam preparation: 12 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

Design, mode of operation and stationary operating behaviour of electrical energy converters / electrical machines

- Direct current machine
- Three-phase synchronous machine
- Three-phase asynchronous machine

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- explain the structure and operating behaviour of the three basic types (1),
- apply equivalent circuit diagrams and system equations of electrical machines (2) and thus calculate the physical quantities required for their operation (2),
- explain the influence of torque and speed on the energy converters (1) and evaluate the respective application possibilities (3),
- to perform steady-state operating point calculations (2).

Learning objectives: Personal competence

After successfully completing this sub-module, students will be able to

acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook). In addition, they are able to reflect on the application of the course content in the context of technology assessment (2). However, personal competences are not specifically tested.
Training materials offered
Slides, supplementary sheets, exercises
Teaching media
Blackboard, projector, animations
Literature
Literature in the current issue: Fischer, R. - Electrical machines, Hanser Verlag Fuest, K.; Döring, P. - Elektrische Maschinen und Antriebe, Springer / Vieweg+Teubner Verlag Farschtschi, A. - Elektromaschinen in Theorie und Praxis, VDE Verlag Spring, E. - Electrical Machines, Springer Verlag Kral, C. - Fundamentals of Drive Technology, Hanser Verlag Kremser, A. - Electrical machines and drives, Springer Verlag

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Electrical Measurements 2 (Electrical Measurements 2)		18
Person responsible for the module	Faculty	
Prof Dr Andreas Maier	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
4	2	Compulsory	6

Recommended prior knowledge
Electrical measurement technology 1, fundamentals of electrical engineering 1 and 2, physics

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Electrical measurement technology 2	4 SWS	4
2.	Practical course in electrical measurement technology 2	2 SWS	2

Submodule		TM abbreviation
Electrical measurement technology 2		**MT2**
Responsible person	Faculty	
Prof Dr Andreas Maier	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
N.N.	in each semester	
Teaching form		
Seminar-based teaching, approx. 20% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
4	4 SWS	English	4

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 40 h Exam preparation: 20h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
1. Basics of sensor technology 2. Measuring amplifier 2.1 Ideal and real operational amplifier 2.2 Circuits and metrological applications 3. Stationary behaviour of measuring systems 3.1 Types and causes of faults 3.2 Methods for linearising characteristic curves 3.3 Compensation of disturbance variables 4. Random measurement errors 4.1 Basic probability calculation 4.2 Measures to reduce random errors 5. Basics of signal processing for measurement engineers 5.1 Palpation 5.2 Quantise 5.3 Signal processing in measurement technology 6. Signal analysis in the frequency range 6.1 Gate timing 6.2 Discrete Fourier Transform (DFT) 6.3 Spectrogram & Fourier-Time-Analysis
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • classify and understand basic sensor principles. understand the function of measurement amplifiers and their practical application. recognise the effects of random and systematic measurement errors. take measures to avoid or minimise measurement errors. Consider basic digital signal processing from a metrology perspective. Understand the effects of rounding operations. Understand different types of signal analysis in the frequency domain.
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, bibliography

Teaching media
Blackboard, computer/beamer

Literature
Kiencke, U., Eger,R.: Messtechnik, Systemtheorie für Elektrotechniker, Springer-Verlag, 2008 Schrüfer, E.: Elektrische Messtechnik, Hanser-Verlag, 2007 Lerch, R.: Elektrische Messtechnik, Springer-Verlag, 2007 Tietze, U.: Halbleiter-Schaltungstechnik, Springer-Verlag, 2009 Von Grüngen, D.: Digitale Singalverarbeitung; 2nd edition; Fachbuchverlag Leipzig im Carl Hanser Verlag, Munich, Vienna; 2002 Oppenheim, A.V.; Schafer,R.W.; Buck, J.R.: Zeitdiskrete Signalverarbeitung; 2nd ed. Pearson Studium; Munich, Boston; 2004

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	TM abbreviation
Practical course in electrical measurement technology 2	**PMT2**

Person responsible	Faculty
Prof Dr Mikhail Chamonine	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Mikhail Chamonine Prof Dr Thomas Fuhrmann	in each semester
Teaching form	
Laboratory practicals	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
4	2 SWS	English	2

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 12 h Colloquium preparation: 10 h Presentation preparation: 10 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

Independent project work in small groups:

- Choice of topic
- Development of a realistic schedule
- Selection of a suitable sensor/hardware/software environment
- Preliminary considerations and investigations
- Construction of a prototype (HW/SW)
- Board design, software optimisation
- Construction of the final device
- Determining the properties (technical data)
- Documentation and presentation
- Entry in the internal WIKI

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- to set up and commission modern MDV systems (1)
- handle typical laboratory measuring instruments safely (2)
- apply the programming principles of MDV systems (2)

- Plan MDV projects (3)
- Estimate measurement errors and minimise them where possible (3)
- work out results systematically and present them to a group (3)
- Organise and supervise larger development projects in groups (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook). Students are also able to work with students from the Bachelor of Business Administration - specialisation "Technology and Management" - module "Technical project work" to jointly plan and realise a small development project from a technical and business point of view and to present it together at the end.
Training materials offered
Tasks, script, exercises with solutions, bibliography
Teaching media
depending on the task
Literature
Schrüfer, E.: Elektrische Messtechnik, Hanser-Verlag, 2007 Lerch, R.: Elektrische Messtechnik, Springer-Verlag, 2010 Tietze, U.: Halbleiter-Schaltungstechnik, Springer-Verlag, 2009

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Fields, Waves and Transmission (Fields, Waves and Transmission Lines)		25
Person responsible for the module	Faculty	
Prof Dr Thomas Stücke	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
5	2	Compulsory	5

Recommended prior knowledge
Fundamentals of electrical engineering

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Fields, waves and cables	4 SWS	5

Submodule	**TM abbreviation**
Fields, waves and cables	**FWL**

Responsible person	Faculty
Prof Dr Thomas Stücke	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Robert Sattler Prof. Dr Oliver Sterz Prof. Dr Thomas Stücke	in each semester

Teaching form
Lecture, exercise portion 10% to 20%

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	4 SWS	German/English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Electric and magnetic fields as static, stationary and dynamic fields
- Electromagnetic waves in space and in waveguides
- Conduction theory with implementation of transformations in the Smith chart
- Pulses on cables
- Antennas as wave type converters

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- name Maxwell's equations and categorise important solutions into static/stationary, quasi-stationary and wave fields (2)
- explain the relationships between electromagnetic fields and their causes using the vector-analytical description of field properties (2)
- calculate electrostatic fields, magnetostatic fields and stationary flow fields (3)

- Capacitance, Inductance and Resistance calculation in simple arrangements and to determine this for real arrangements by means of software-based field calculation (3)
- explain the skin effect (2) and calculate the AC resistance of cuboid and cylindrical conductors (3)
- interpret the wave equation in the time and frequency domain (2)
- describe shaft characteristics, shaft properties and material influence (2)
- explain the behaviour of plane waves at interfaces (2), identify polarisation (2), calculate reflection, transmission and energy flow (3)
- Classify cable types, waveguide modes and their properties (2)
- Explain the significance of characteristic impedance and determine it for coaxial conductors and strip conductors (3)
- by means of Smith chart simple circuits to calculate and dimension line transformations (3)
- Calculate pulse propagation on cables (3)
- Distinguish between the near field and far field of antennas (2)
- specify the characteristic numbers of simple antennas (2) and use them to perform calculations (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Slides, script, exercises, animations, bibliography
Teaching media
Projector, blackboard, overhead, computer
Literature
Detlefsen J., Siart,u.: Fundamentals of high frequency technology. 4th edition. Oldenbourg (2012) Henke, F.: Electromagnetic fields. 4th edition. Springer (2011) Krischke, A.: Rothammels Antennenbuch. 13th edition. DARC (2013) Kark, K.: Antennas and radiation fields. 4th edition. Vieweg (2011) Hayt, W.: Engineering Electromagnetics. 8th edition. McGraw Hill (2011) Sadiku, M.: Elements of Electromagnetics (The Oxford Series in Electrical and Computer Engineering). 6th edition. Oxford University Press (2014)

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track 6 AB LT6A&B - Technical Mode of Expression and Writing	28

Person responsible for the module	Faculty
Prof Dr Johannes Reschke	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
5	2	Compulsory	3

Recommended prior knowledge
Language Track 1-4 A/B

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track 6 AB LT6A&B - Technical Mode of Expression and Writing	2 SWS	3

Submodule		TM abbreviation
Language Track 6 AB LT6A&B - Technical Mode of Expression and Writing		**LT6A&B**
Responsible person	Faculty	
Prof Dr Johannes Reschke	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Johannes Reschke	only in the winter semester	
Teaching form		
Seminar teaching (SU)+ Exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	2 SWS	German/English	3

Time required:

On-campus study programme	Self-study
30 h	Preparation and follow-up 30h+ 30h paper

Study and examination performance
see "Study plan table"
Authorised aids for proof of performance
see "Study plan table"

Contents
Preamble: In this class, students read and discuss technical manners and present topics in the field of Engineering to peers. This module covers both, technical German and technical English Review of fundamental vocabulary relevant to technical fields Specific technical vocabulary and terminology related to the field of Electrical Engineering and Information Technology Understanding and analysing authentic technical texts (e.g., manuals, research papers, specifications) Writing various types of technical documents in English (e.g., reports, instructions, specifications, emails) Principles of clear, concise, and audience-oriented writing Structuring technical documents effectively (e.g., using headings, subheadings, lists) Visual aids in technical documentation (e.g., diagrams, graphs, tables) Practicing spoken technical communication (e.g., presentations, discussions)
Learning objectives: Professional competence
After a successful completion of the sub-module, students will be able to After a successful completion of the sub-module, students will be able to, • Understand and interpret technical documentation in English and German (2)

- Communicate technical information accurately in both English and German (2)
- Apply the principles of clear and concise technical writing in both languages (2)
- Know certain aspects of various types of technical documents (e.g., reports, instructions, specifications) in English and/or German (1)
- Understand and apply relevant standards and conventions for technical documentation (1)
- Effectively present technical information to different audiences in both languages. (1)

Learning objectives: Personal competence
After a successful completion of the sub-module, students will be able to After a successful completion of the sub-module, students will be able to, • Understand and communicate technical problems in German and English (2). • Participate effectively in technical conversations (2). • Find additional resources and references in order to get a deeper knowledge in technical English/German (2).Additionally, to the above-mentioned personal skills, after completing this course, students can formulate (3) and reflect (2) typical problem statements in the field of Electrical Engineering and Information Technology.
Training materials offered
Lecture slides, scientific articles
Teaching media
Blackboard, notebook, projector, poster, scientific articles
Literature
N. Brieger and A. Pohl, Technical English: Vocabulary and Grammar, 1st ed. Oxford: Summertown Publishing, 2002. P.-K. Budig, Langenscheidt Fachwörterbuch kompakt Elektrotechnik und Elektronik Englisch: English-German, German-English, 4th ed. Berlin, Munich, Vienna, Zurich: Langenscheidt, 2012. R. Voss, Scientific work: ... leicht verständlich!, 9th ed. Munich, Tübingen: UVK Verlag; Narr Francke Attempto Verlag, 2024. L. Geiges, formulations, sentence beginnings and outlines for academic writing: Wissenschaftliches Schreiben ohne Stress ; mit Anleitungen, Checklisten und Beispielen zum Kopieren für Aufsatz, Hausarbeit, Kommentar, Essay, Thesenpapier, Bachelor-/Masterarbeit und vieles mehr. Place cannot be determined: Verlag für Wissenschaft und Studium, 2023. J. Swales and C. B. Feak, Academic writing for graduate students: Essential tasks and skills, 3rd ed. Ann Arbor: The University of Michigan, 2012. G. Graff, C. Birkenstein, and R. Durst, "They say, I say": The moves that matter in academic writing. New York, London: W.W. Norton & Company, 2018.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track A 4 LT4A	22a

Person responsible for the module	Faculty
Lucie Eireiner (LB)	General science programme

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
4	2	Compulsory	6

Recommended prior knowledge
German language skills at B1 level

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track A 4 LT4A - Application training/application training	6 SWS	6

Submodule	**TM abbreviation**
Language Track A 4 LT4A - Application training/application training	**LT4A**

Responsible person	Faculty
Lucie Eireiner (LB)	General science programme
Teacher / Lecturer	Offer frequency
N.N.	in each semester

Teaching form
Seminar lessons / practical exercise

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	6 SWS		6

Time required:

On-campus study programme	Self-study

Study and examination performance
Application portfolio
Authorised aids for proof of performance
see literature

Contents
In this practice-orientated course, participants with B1/B2 level will specifically improve their German language skills on the subject of "job applications and job interviews". The course teaches language, cultural and content-related skills that are necessary for a successful application in German-speaking countries. In this hands-on course, participants with a B1/B2 level systematically improve their German language skills related to the topic of "applications and job interviews." The course provides linguistic, cultural, and content-related competencies that are essential for a successful application process in German-speaking countries.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Write CVs and letters of application (cover letter, letter of motivation) (3) • Create and design professional application documents (3) • Use vocabulary and expressions relating to job applications, careers and the workplace with confidence (2) • answer typical questions in a job interview (3) • Playing out job interviews and procedures (role plays) (3) • Analyse job interviews (2)

- Using body language and non-verbal communication appropriately in conversation (2)
- Consider intercultural particularities when applying for jobs in Germany (3)

- Writing résumés and application documents (cover letters, letters of motivation) (3)
- Creating and structuring professional application materials (3)
- Confidently using vocabulary and phrases related to applications, professions, and the workplace (2)
- Answering typical job interview questions (3)
- Practicing job interviews and processes through role plays (3)
- Analysing job interviews (2)
- Using body language and non-verbal communication appropriately during interviews (2)
- Taking intercultural aspects of job applications in Germany into account (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • use the language confidently in the written and oral application process (3) • master the job-related vocabulary in the application process (3) • express and present yourself confidently in the application process (3) • optimise opportunities on the German-speaking labour market (3) • Using language confidently in both the written and spoken application process (3) • Mastering job-related vocabulary for the application process (3) • Expressing oneself and presenting confidently during the application process (3) • Optimising one's chances on the German-speaking job market (3)
Teaching media
Projector, blackboard, videos/audios, interactive exercises, ELO
Literature
tba

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Language Track A 5 LT5A		27a
Person responsible for the module	Faculty	
N.N.	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
5	2	Compulsory	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track A 5 LT5A		

Submodule		TM abbreviation
Language Track A 5 LT5A		**LT5A**
Responsible person	Faculty	
	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
N.N.		
Teaching form		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]

Time required:

On-campus study programme	Self-study

Study and examination performance

Literature

Module name (English name if applicable)	Module code or no.
Language Track B 4 LT4B	22b

Person responsible for the module	Faculty
Prof Dr Gabriele Blod	Applied natural and cultural sciences
Ulrike de Ponte	Applied natural and cultural sciences
Prof Dr Katherine Gürtler	Applied natural and cultural sciences
Prof Dr Thomas Kriza	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
4	2	Compulsory	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track B 4 LT4B	4 SWS	5

Notes on compulsory occupancy or options
Students in Language Track B can choose from different modules of the AW programme and the language programme offered by the Faculty of Applied Sciences and Cultural Studies in order to obtain the required ECTS per Language Track B module. Within the AW programme, only lectures with an international or intercultural reference can be chosen. For LT3-4, in addition to the AW programme and the language track, students can also choose lectures from the "International Handlungskompetenzen" programme offered by the Faculty of Applied Natural Sciences and Cultural Studies. Two of the language track B modules should cover two consecutive language modules of the same language, in order to guarantee a profound knowledge of at least one language other than the mother tongue. If the chosen courses do not provide at least the number of ECTS required for LT1-5B, several courses must be combined.

Submodule	TM abbreviation
Language Track B 4 LT4B	**LT4B**

Person responsible	Faculty
Prof Dr Gabriele Blod Ulrike de Ponte Prof. Dr Katherine Gürtler Prof. Dr Thomas Kriza	Applied natural and cultural sciences
Teacher / Lecturer	**Offer frequency**
N.N.	in each semester

Teaching form
lecture-specific

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
4	4 SWS		5

Time required:

On-campus study programme	Self-study
lecture-specific	lecture-specific

Study and examination performance
see "Study plan table"
Authorised aids for proof of performance
see "Study plan table"

Contents
lecture-specific
Learning objectives: Professional competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Learning objectives: Personal competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Training materials offered
lecture-specific
Teaching media
lecture-specific

Literature
lecture-specific
Further information on the course
Responsible for AW-programme: Prof. Dr Gabriele Blod and in future Prof. Dr Kriza Responsible for language-programme: Prof. Dr Katherine Gürtler Responsible for "International Competence": Ulrike de Ponte

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Language Track B 5 LT5B	27b

Person responsible for the module	Faculty
Prof Dr Gabriele Blod	Applied natural and cultural sciences
Ulrike de Ponte	Applied natural and cultural sciences
Prof Dr Katherine Gürtler	Applied natural and cultural sciences
Prof Dr Thomas Kriza	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
5	2	Compulsory	5

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Language Track B 5 LT5B	4 SWS	5

Notes on compulsory occupancy or options
Students in Language Track B can choose from different modules of the AW programme and the language programme offered by the Faculty of Applied Sciences and Cultural Studies in order to obtain the required ECTS per Language Track B module. Within the AW programme, only lectures with an international or intercultural reference can be chosen. For LT3-4, in addition to the AW programme and the language track, students can also choose lectures from the "International Handlungskompetenzen" programme offered by the Faculty of Applied Natural Sciences and Cultural Studies. Two of the language track B modules should cover two consecutive language modules of the same language, in order to guarantee a profound knowledge of at least one language other than the mother tongue. If the chosen courses do not provide at least the number of ECTS required for LT1-5B, several courses must be combined.

Submodule	TM abbreviation
Language Track B 5 LT5B	**LT5B**

Responsible person	Faculty
Prof Dr Gabriele Blod Ulrike de Ponte Prof. Dr Katherine Gürtler Prof. Dr Thomas Kriza	Applied natural and cultural sciences
Teacher / Lecturer	**Offer frequency**
N.N.	in each semester
Teaching form	
lecture-specific	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	4 SWS		5

Time required:

On-campus study programme	Self-study
lecture-specific	lecture-specific

Study and examination performance
see "Study plan table"
Authorised aids for proof of performance
see "Study plan table"

Contents
lecture-specific
Learning objectives: Professional competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Learning objectives: Personal competence
After successfully completing the sub-module, students are in a position to develop lecture-specific
Training materials offered
lecture-specific
Teaching media
lecture-specific

Literature
lecture-specific
Further information on the course
Responsible for AW-programme: Prof. Dr Gabriele Blod and in future Prof. Dr Kriza Responsible for language-programme: Prof. Dr Katherine Gürtler Responsible for "International Competence": Ulrike de Ponte

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Electronics Lab Courses	26

Person responsible for the module	Faculty
Prof Dr Norbert Balbierer Prof Dr Rainer Holmer	Electrical engineering and information technology Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
5	2	Compulsory	5

Recommended prior knowledge
For practical course Microcomputer Technology: Lecture Microcomputer Technology For practical course in analogue electronics: Lecture "Electronic components (BE)"

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Internship analogue electronics	2 SWS	2
2.	Practical course in microcomputer technology	2 SWS	3

Submodule	**TM abbreviation**
Internship analogue electronics	**PAE**

Responsible person	Faculty
Prof Dr Norbert Balbierer Prof Dr Rainer Holmer	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Florian Aschauer Prof. Dr Mathias Bischoff Prof. Dr Rainer Holmer Prof. Dr Christian Schimpfle	in each semester

Teaching form
Laboratory tests

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	2 SWS	German/English	2

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 32 h (test elaborations)

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Measurements on electronic components and circuits • Characteristic curves and extraction of model parameters for bipolar transistors • Switching behaviour and switching times of the bipolar transistor • Switching behaviour and switching times of power MOSFETs • Amplifier circuits with bipolar and field-effect transistors • Properties and simple applications of operational amplifiers
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • analyse and interpret the electronic properties of bipolar and field-effect transistors (3) • Create a description of transistor behaviour using simple models (2) • Analyse and interpret the static and dynamic behaviour of operational amplifiers (3)

- Simple electronic circuits for switch and amplifier applications analyse (3)
- create measuring circuits to determine different properties of electronic components and circuits (2)
- Making optimum use of the possibilities of modern electronic measuring devices (2)
- Create meaningful visualisations of measurement results (2)
- analyse measurement results to determine parameters (3)
- Develop suitable concepts for solving measurement tasks in the field of analogue electronics (3)
- Link technical information from different sources (measurements, simulations, data sheets) (2)
- Evaluate and select electronic components with regard to different circuit applications (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Test instructions, data sheets, bibliography
Teaching media
Laboratory measuring stations, overhead projector, beamer
Literature
[1] M. Reisch: Elektronische Bauelemente, Springer, 2nd edition, 2007 [2] U. Tietze, C: Schenk: Halbleiter-Schaltungstechnik, Springer, 13th edition, 2010

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	TM abbreviation
Practical course in microcomputer technology	**PMC**

Responsible person	Faculty
Prof Dr Norbert Balbierer Prof Dr Rainer Holmer	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Norbert Balbierer Matthias Hausladen (LB) Prof Dr Johannes Reschke Armin Schön (LB)	in each semester

Teaching form
Laboratory internship

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	2 SWS	German/English	3

Time required:

On-campus study programme	Self-study
30 h	Elaboration of the experiments: 60 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Familiarisation with the IDE for (modular) hardware-related programming (assembler) • Use of SW (debugger) and HW tools (logic analyser) for troubleshooting (testing and debugging) • Processing of several tasks of increasing scope and difficulty (from the areas of basic functions, communication/serial interface, LC display or operation), Automat/FSM • Work on a different task per semester (voltmeter, menu with encoder e.g. drinks machine, random numbers e.g. dice, reaction tester, DMA/PEC, NeoPixel etc.)
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • understand and be able to use ARM Cortex-M3/4 (arithmetic instructions, addressing types, jumps) (3) • Know the basic functions of the IDE (simple tasks: running light, view of memory contents) (1)

- Peripheral units: ADC, timer/counter, serial interface (I2C, SEI) use to can (2)
- be able to use subroutines and interrupt handling (2)
- Know the serial interface protocol (I2C, SPI) (1)
- Peripheral connection: to be able to use an alphanumeric LC display (2)
- flowcharts/structure diagrams and documentation before the actual coding
- To be able to structure software into subroutines, macros (2)
- be able to create assembler and C programmes (2)
- Getting to know new peripherals (1)
- Know the functions of the logic analyser for HW/SW troubleshooting and debugging (1)
- realise that "trial and error comes before study" (3)

Learning objectives: Personal competence

After successfully completing this sub-module, students will be able to

- Understand content from English-language data sheet (1)
- Know troubleshooting strategies (1)
- Presentation, i.e. demonstration of the self-created executable programmes (2)
- be able to defend their own chosen solution approach (2)

Training materials offered

Tasks, assembly description (circuit diagram), assembler and debugger documents, lecture notes (see module MC), English-language data sheet

Teaching media

Specially developed microcomputer boards (RapidIO, traffic light board), test signal generator, PC, overhead projector, blackboard, computer/beamer

Literature

Basic literature:

English-language technical documentation: Instruction Set and Technical Manual of the processor manufacturer

Embedded Systems: Introduction to ARM Cortex-M-Microcontrollers, Jonathan W. Valvano, 2015, ISBN 978-14775-0-8992

Embedded Systems with Arm Cortex-M3 Microcontrollers in Assembly Language and C, Yifeng Zhu, 2014, E-Man Press, ISBN 978-0-98826926-2

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Practical semester (Practical)		29
Person responsible for the module	Faculty	
Prof Dr Anton Horn	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
6	2	Compulsory	22

Mandatory requirements
For industrial placement: see study and examination regulations For practical seminar: admission to practical semester
Recommended prior knowledge
none

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Internship		20
2.	Practical seminar	2 SWS	2

Submodule		**TM abbreviation**
Internship		**PR**
Responsible person	Faculty	
Prof Dr Anton Horn	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Anton Horn	in each semester	
Teaching form		
Internship		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
6			20

Time required:

On-campus study programme	Self-study
	600 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Engineering work • Project work in the industry • Preparation of technical reports A maximum of 3 of the following fields of work must be selected: • Research and development • Project planning and design • Production and work preparation • Planning, operation and maintenance of systems • Final and acceptance tests, quality assurance • Technical sales
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • indicate different fields of work in companies (1) and assess them (3), • apply the knowledge acquired during their studies to solve problems (3), • structure (3) and plan (3) larger projects.

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • work purposefully in a team (3), • assess time constraints (3) and make efficient use of the time available (3), • recognise your own strengths and weaknesses (3). The personal competences listed in the introduction to this module handbook also apply.
Training materials offered
• Database of companies authorised for industrial internships • Information sheets for preparing the internship report
Literature

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	**TM abbreviation**
Practical seminar	**PS**

Responsible person	Faculty
Prof Dr Anton Horn	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Anton Horn	in each semester

Teaching form
Seminar

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
6	2 SWS	German/English	2

Time required:

On-campus study programme	Self-study
28 h	Preparation lectures: 32 h

Study and examination performance
20-minute lectures with discussion, compulsory attendance at lectures No grading of the presentations
Authorised aids for proof of performance
all

Contents
• Structure of technical reports (internship report) • Formal organisation / structure of a presentation • Dealing with different media • Practising presentations in a protected environment (preparation of a thesis paper: handout, 1 DIN A4; presentation of a project from the internship) • Preparation of a presentation on a current topic (including internet research)
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • prepare and present a presentation on their own projects carried out during the internship (3), • estimate the duration of a presentation in advance (3), • to categorise body language, eye contact with the audience and voice in terms of their significance for a presentation (2) and to apply them to their own presentations (3), • to name (1) and assess (3) potential employers in the region, • indicate (1) and assess (3) various fields of work in companies.

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook). In addition, after successfully completing the module, students are able to • communicate efficiently and purposefully, even in larger groups (3), • to convey a message with a lecture (3), • give constructive feedback on other people's presentations (3), • respond constructively to feedback (3).
Teaching media
Computer/beamer, blackboard
Literature
Garr Reynolds: Presentation Zen: Simple Ideas on Presentation Design and Delivery, New Riders, 2019

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Computer Architecture		19
Person responsible for the module	Faculty	
Prof Dr Norbert Balbierer	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
4	2	Compulsory	6

Recommended prior knowledge
For lecture Microcomputer Technology: Computer Science 1 (C-Programming)

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Microcomputer technology	4 SWS	4
2.	Internship Programmable Logic	2 SWS	2

Submodule		TM abbreviation
Microcomputer technology		**MC**
Responsible person	Faculty	
Prof Dr Norbert Balbierer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Norbert Balbierer	in each semester	
Teaching form		
Seminar-based teaching, laboratory exercises, proportion of exercises> 30 %		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
4	4 SWS	English	4

Time required:

On-campus study programme	Self-study
Lecture: 56 h	Preparation and follow-up: 48 h; Exam preparation: 16 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Computer architectures and memory - Hardware-related programming of the ARM Cortex-M processor in assembler and C • Overview of the ARM Cortex-M3/M4 • Memory organisation, pipeline, stack, clock • Command set • Subroutines, macros and interrupts • Development environment • Software development process (compiler, assembler, linker) • Finite automata - Peripherals • GPIOs • SysTick and GPT timer • A/D converter • Serial interfaces (UART, SPI, I2C) - Lecture-accompanying exercises in the laboratory with ARM Cortex-M3/4 • Get to know Toolchain (Keil, GNU arm-none-eabi) • Programming in assembler and C • Debugging and troubleshooting - Possible own work with evaluation boards and in the laboratory
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • understand and be able to apply the functionality of processors and microcontrollers (3) • understand and develop assembler programs for ARM instruction set (3) • document code appropriately (flowchart, comments) (2) • Perform hardware-related programming in assembler and C • To be able to handle interrupt system (2) • Know how peripheral drivers work (1) • Knowing how to divide complex (programming) tasks into modules and interfaces (1)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • Be able to handle technical documents (e.g. data sheets, reference manuals) independently (2) • Know English specialised vocabulary (1)

Training materials offered
Scripts, English-language reference manuals (ARM Cortex-M), textbooks, sample programmes in assembler and C
Teaching media
Computer / projector, blackboard, evaluation boards and logic analyser, webcam
Literature
J. Yiu,The Definitive Guide to the ARM Cortex-M3 , Elsevier 2010 H. Meier, Microcomputer technology, Lecture notes, OTH Regensburg F. Graf, Microcomputer technology, Lecture notes, OTH Regensburg N. Balbierer, Microcomputertechnik, Vorlesungsskript, OTH Regensburg ARM, ARMv7-M Architecture Reference Manual, Firmenschrift ARM, ARM Cortex-M4 Technical Reference Manual, company publication ARM, Procedure Call Standard for the ARM Architecture, company publication J. Valvano, Introduction to ARM Cortex-M Microcontrollers Vol. 1, 2015

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	TM abbreviation
Internship Programmable Logic	**PPL**

Person responsible	Faculty
Prof Dr Thomas Fuhrmann	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Florian Aschauer Prof Dr Thomas Fuhrmann Prof Dr Detlef Jantz Prof Dr Christian Schimpfle	in each semester

Teaching form
Laboratory internship

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
4	2 SWS	English	2

Time required:

On-campus study programme	Self-study
30 h	Preparation and follow-up: 25 h Exam preparation: 5 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Conception of a development project in group work according to the list of suggestions or own refinement. • Realisation of a development project with using a current development system with VHDL. • The contents of the corresponding lecture are intensively deepened. • A quick introduction is via small starting tasks. • The chosen project is worked on in a group, as is usual in an industrial activity. • The group organises itself, defines the interfaces, sets the schedule and divides up the tasks. According to the plan, the project goal is approached and realised over the course of the semester.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • structure a complex task (2)

- design logical sequences using the tools learnt from the previous events and VHDL (3)
- simulate digital circuits with VHDL (3)
- synthesise digital circuits with VHDL (3)
- to deal with a current development system (3)
- assess their own possibilities for technical development work (2)
- assess the complexity of planning and realisation in technical development work (1)
- organise a project working group (2)
- Carry out development work on a VHDL project within a group (2)
- Work results in presentations, moderation, group work, group leadership (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Tasks, structure description, script, exercises, data sheets, bibliography
Teaching media
VHDL development environment, laboratory PC, projector on the computer, blackboard
Literature
Textbook Digital Technology: An Introduction with VHDL ; Jürgen Reichardt ; Oldenbourg Wissenschaftsverlag, 2009

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Control Engineering		23
Person responsible for the module	Faculty	
Prof Dr Birgit Rösel	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
5	2	Compulsory	5

Recommended prior knowledge
Signals and systems module

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Control engineering	4 SWS	5

Submodule	**TM abbreviation**
Control engineering	**RT**

Responsible person	Faculty
Prof Dr Birgit Rösel	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Birgit Rösel	only in the winter semester

Teaching form
Seminar-based teaching: 30% exercises and 10% practical training as well as blended learning teaching units

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
5	4 SWS	English	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up: 60 h Exam preparation: 30 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Description of linear systems in the time and frequency domain as well as in state space
- Modelling, standardisation and linearisation
- Properties of important transmission elements and their interconnections
- Stability testing with various methods
- Controller design with methods of different classes from empirical setting rules to the design of controllers in state space

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- explain (1) and illustrate the structure and mode of operation of control loops, investigate their behaviour (2) and differentiate between open-loop and closed-loop control (3)
- describe technical systems with a mathematical model (2) and simplify, linearise and standardise it appropriately (2) and analyse the model (3)
- describe (2), analyse (3) and synthesise (3) linear, time-invariant systems and their properties in the time and frequency domain as well as in state space using various methods

- characterise different methods for determining a suitable controller (1), to use them (2) and to assess their suitability (3)
- present the concept of stability (1), use different methods for stability testing (2) and assess the stability of control loops (3)
- to develop new content from technical texts (2) and present technical contexts in their own words (3)
- work on control engineering tasks with the help of the Matlab programme (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • recognise technical correlations and reproduce them in correct technical language (3), ask technical questions to the lecturer (3) and present technical content to an audience (2). • Recognise the need to prepare for the events (2) and motivate themselves to participate (3) • name the basic principles of teamwork (1) and work in a team (2) • to name the feedback rules (1) and to give qualified feedback (2) • name (1) and apply (2) the principles of good scientific practice
Training materials offered
Script, exercises, practical course material, teaching texts and screencasts, weekly plans, Matlab exercise environment. Teaching materials in English.
Teaching media
Blackboard, projector, audience response system, elearning platform, Matlab exercise environment, Matlab simulation environment.
Literature
Lunze, J.: Regelungstechnik 1/2, Springer, 2013 Föllinger, O.: Regelungstechnik, Hüthig, 1994 Reuter, M.; Zacher, S.: Regelungstechnik f. Ingenieure, Vieweg-Verlag, 2008 Unbehauen, H.: Regelungstechnik I, Vieweg-Verlag, 2005
Further information on the course
The course contains elements of blended learning - in other words, it requires a thorough Preparation in the self-learning phase. For this purpose, either so-called teaching texts with associated tasks are provided. The answers to these form the basis for the subsequent attendance phase. Alternatively, screencasts are provided for the self-study phase, which are taken up and deepened in the classroom sessions.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Signals and Systems	20

Person responsible for the module	Faculty
Prof Dr Robert Sattler	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
4	2	Compulsory	9

Recommended prior knowledge
AC calculation, circuit analysis, GE2 exam passed

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Signals and systems	8 SWS	9

Submodule		TM abbreviation
Signals and systems		**SUS**
Responsible person	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Susanne Hipp Prof. Dr Robert Huber Prof. Dr Andreas Maier Prof. Dr Robert Sattler Prof. Dr Armin Sehr Prof. Dr Oliver Sterz Prof. Dr Thomas Stücke	in each semester	
Teaching form		
Seminar-based teaching with approx. 15-20% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
4	8 SWS	English	9

Time required:

On-campus study programme	Self-study
112 h	Preparation and follow-up: 94 h Exam preparation: 64 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Second location theory Two-port matrices and parameters, interconnection of two-ports, symmetry properties, connected two-ports - Signals in the time domain Characterisation, scaling, strain, displacement, elementary signals - Systems System properties, representation of LTI systems with • Differential equation and signal flow diagram • Impulse response and convolution • Transfer function, pole-zero diagram • Frequency response, Bode diagram Elementary transfer elements (P, D, I, PT1, PT2 element) Interconnection of transmission elements, system identification from the floor diagram Elementary filters (low, high and bandpass, bandstop) - Signal display in the frequency and image range • Fourier series (real and complex) • Characteristics of periodic signals (distortion factor, active reactive and distortion reactive power) • Fourier transformation • Laplacetransformation Calculation of the system response using Fourier series, Fourier and Laplace transformation - Switching processes in electrical networks • Calculating in the time domain • Calculate in the image area - Discrete-time signals and systems AD conversion, sampling theorem, elementary signals • Discrete-time systems in the time domain (impulse response, convolution, difference equation, signal flow diagram) • Discrete-time signals in the frequency domain (discrete-time Fourier transform (DTFT)) • z-transformation and reverse transformation • Discrete-time LTI systems Calculation of the system response in the time and image domain, classification of systems

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know the basic concepts of second locus theory and signal and system theory in the time and image domain (1). • apply the acquired knowledge to solve known types of problems from the field of two-locus theory and signal and system theory using analytical and graphical methods (2).

- with an understanding of the underlying mathematical laws for the solution previously unknown issues in the field of second locus theory and signalling and systems theory (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, slides, programme code, bibliography
Teaching media
Blackboard, computer/beamer
Literature
Albach, M.: Fundamentals of Electrical Engineering 2, Pearson Studium, Munich 2005 Schmid, L.-P. / Schaller, G. / Martius, S.: Grundlagen der Elektrotechnik 3. Pearson Studium, Munich 2006. Lunze, Klaus: Theory of alternating current circuits. Verlag Technik, Berlin 1991 Girod, B., Rabenstein, R., Stenger, A.: Einführung in die Systemtheorie. Teubner, Wiesbaden 2007. Weber: Laplace, Fourier and z-transforms, fundamentals and applications for engineers and scientists. Vieweg and Teubner Publishers.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Bachelor thesis with presentation (Bachelor Thesis with presentation)		32
Person responsible for the module	Faculty	
Prof Dr Johannes Reschke	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
8	3	Compulsory	15

Mandatory requirements
see SPO
Recommended prior knowledge
All modules of the degree programme

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Presentation		3
2.	Written elaboration		12

Submodule	TM abbreviation
Presentation	**BP**

Responsible person	Faculty
Prof Dr Johannes Reschke	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Supervising professor	in each semester

Teaching form
Independent engineering presentation of a practice-orientated project under supervision

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
8		German/English	3

Time required:

On-campus study programme	Self-study
—	Preparation of the bachelor thesis presentation: 90 h

Study and examination performance
Presentation, 20 minutes
Authorised aids for proof of performance
all

Contents
Selection, preparation and presentation of the results of the Bachelor's thesis

Learning objectives: Professional competence

After successfully completing the sub-module, students are able to prepare and present technical and scientific contexts in an audience-orientated manner.

To this end, the following sub-competences are acquired or deepened:

- Presentation techniques (2)
- Visualisation of technical-scientific contents (Graphics, tables, diagrams) (2)
- Selection of information relevant to the audience (2)
- Topic-related, meaningful structuring of the presentation (2)

Learning objectives: Personal competence

After successfully completing this sub-module, students will be able to

- plan a complex task independently and complete it on time (2)

- distinguish between material and immaterial information (2)
- communicate complex interrelationships in an understandable way both verbally and in writing (2)
- formulate a speech freely in front of groups (2)
- respond to the audience in the presentation (3)

Literature
Samac K., Prenner M., Schwetz H.: Die Bachelorarbeit an Universität und Fachhochschule, facultas wuv, 2008

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		TM abbreviation
Written elaboration		**BA**
Responsible person	Faculty	
Prof Dr Johannes Reschke	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Supervising professor	in each semester	
Teaching form		
Independent engineering work on a practice-orientated project under supervision		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
8		German/English	12

Time required:

On-campus study programme	Self-study
—	360 h

Study and examination performance
written bachelor thesis
Authorised aids for proof of performance
all

Contents
• Independent engineering work on a practice-orientated project • Theoretical, constructive experimental task with detailed description and explanation of its solution • Preparation and documentation of the results in scientific form • Preparation and presentation of the results of the Bachelor's thesis
Learning objectives: Professional competence
After successfully completing the sub-module, students are able to apply the competences acquired during their studies in the common problem context of an engineering task in an independent, creative combination and to expand them using scientific methods (3). To this end, the following sub-competences are acquired or deepened: • Understanding both technical details (2) and as well as interdisciplinary contexts (3) • Creative application and interdisciplinary combination of competences acquired during the degree programme to solve complex tasks (3) • Development of results with scientific and practical procedures (3)

- Systematic approach with validation of the results using scientific methods (measurements, experiments, literature research) (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • plan a complex task independently and complete it on time (2) • conduct a scientific and technical literature search (2) • structure complex problems and work through them successively (2) • distinguish between material and immaterial information (2) • communicate complex interrelationships in an understandable way both verbally and in writing (2) • Find solutions to complex problems through scientific discourse (2)

Literature
Hering L., Hering H., : Technische Berichte, Vieweg Verlag 2007 Samac K., Prenner M., Schwetz H.: Die Bachelorarbeit an Universität und Fachhochschule, facultas wuv, 2008 K. Smarsly and K. Dragos, Scientific Writing in Engineering. Ahrensburg: tredition, 2024. F. Lindenlauf, Wissenschaftliche Arbeiten in den Ingenieur- und Naturwissenschaften: Ein praxisorientierter Leitfaden für Semester- und Abschlussarbeiten. Wiesbaden, Heidelberg: Springer Spektrum, 2022. B. Petri#, The Thesis Writing Journeys of Bachelor's and Master's Students: A Transnational European Perspective, 1st ed. Bristol: Multilingual Matters, 2025.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Acoustic communication		
Person responsible for the module	Faculty	
Prof Dr Armin Sehr	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Acoustic communication	4 SWS	5

Submodule	TM abbreviation
Acoustic communication	**AK**

Person responsible	Faculty
Prof Dr Armin Sehr	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Benedikt Bugl (LB) Prof Dr Armin Sehr	only in the summer semester

Teaching form
approx. 75% seminar-based teaching, approx. 25% practical training

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Sound quantities: sound power, sound intensity, sound level, sound pressure, sound velocity
- Sound fields, sound waves
- Plane wave, spherical wave, wave reflection, wave propagation
- Models for sound sources, sound fields and radiation
- Bundling, directional factor, directional dimension, bundling dimension
- Electromechanical analogues
- Electroacoustic transducers: microphones and loudspeakers
- Reverberation time, reverberation radius, sound absorber, absorption coefficient
- Anatomy and physiology of hearing
- Acoustic perception, psychoacoustic parameters
- Spatial hearing and auditory signal processing
- Acoustic measurement technology
- Practical experiments

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- explain important quantities in technical acoustics (2).
- calculate sound fields (2).

- analyse electromechanical systems with the help of electromechanical analogies (3).
- interdisciplinary work (acoustics, mechanics, electrical engineering) (3).
- explain the principles of electro-acoustic transducers (2).
- Selecting suitable microphones for a specific task (3).
- name (1) and explain (2) the properties of loudspeakers.
- to measure loudspeaker frequency responses (3).
- to measure room impulse responses (3).
- describe (2) and evaluate (3) the acoustics of a room using different parameters.
- Explain (2) and recognise (2) the proximity effect and pressure accumulation effect.
- Critically assess microphone and speaker data (3).
- to assess the measurement results (3).
- name psychoacoustic effects (1) and categorise their significance (2).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Lecture slides, exercises, experiment instructions
Teaching media
Blackboard, projector, experimental set-ups
Literature
M. Zollner: Electroacoustics, Springer R. Lerch, G. Sessler: Technical Acoustics, Springer H. Fastl, E. Zwicker: Psychoacoustics, Springer
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Plant and power plant technology (Power Plant Technology)	

Person responsible for the module	Faculty
Prof Dr Robert Leinfelder	Mechanical engineering

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Contents
See following pages

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Plant and power plant engineering	4 SWS	5

Notes on compulsory occupancy or options
For a description of the module Power Plant Systems, see the module handbook for the Bachelor's degree programme in **Mechanical Engineering** (Faculty of Mechanical Engineering) on the homepage of the degree programme: https://www.oth-regensburg.de/fakultaeten/maschinenbau/studiengaenge/ bachelor-maschinenbau.html

Submodule		**TM abbreviation**
Plant and power plant engineering		**ACT**
Person responsible	Faculty	
Prof Dr Robert Leinfelder	Mechanical engineering	
Teacher / Lecturer	Offer frequency	
Prof Dr Robert Leinfelder	only in the winter semester	
Teaching form		
Seminar lessons, exercise		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
1) Energy demand, energy conversion and social relevance 2) Definitions of terms in the energy sector and energy supply in Germany 3) Methods for calculating and visualising primary energy consumption 4) Classification of conventional energy conversion plants as part of the overall energy supply in Germany 5) Conservation of energy (1st law) 6) Irreversibility (2nd main theorem) 7) Thermodynamic cycle processes for heat engines 8) Steam power plants 9) Gas turbine power plants 10) Combination of gas and steam turbine power plants (G&D power plants) 11) Nuclear power plants
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • to know the energy conversion in general (1) • handle the thermodynamic principles of energy conversion by power plants (2)

- the structure of the power plant, its main components, its design and technical Significance, extraction and properties of fuels used fuels used, the flue gas cleaning and disposal of fuels (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises
Teaching media
Computer/beamer, overhead projector, blackboard, video, exhibits
Literature
Bibliography
Further information on the course
The course is offered by the Faculty of Mechanical Engineering.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Drive Technology (Electrical Drives)		
Person responsible for the module	Faculty	
Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Fundamentals of electrical engineering 1-3 Lecture Electrical Energy Converters Lecture Electrical Machines

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Drive technology	4 SWS	5

Submodule		**TM abbreviation**
Drive technology		**AT**
Person responsible	Faculty	
Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Bernhard Hopfensperger Dr Thomas Kühner (LB)	in each semester	
Teaching form		
Seminar-based teaching, 10-15% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German/English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Structure and Mode of operation electrical drives with electrical Drive machine, gearbox, driven machine, power converter, power supply, control system, operating conditions, losses, heating process, efficiency classes, • Investigation of the mechanics of the drive with determination of the stationary operating point, torque-speed characteristics, influence of a gearbox and calculation of acceleration and braking processes, • Speed adjustment of direct current and three-phase machines with power electronic converters/frequency converters.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • the interaction of electric drive machines and mechanical machines (1) • describe how frequency inverters work (1) • calculate operating points and speed curves of electrical drive machines (2) • calculate losses and temperatures occurring during operation of electric drives (2)

• Design drives for mechanical machines, consisting of electrical machines and power converters (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Presentation, supplementary sheets, exercises, formulary
Teaching media
Computer/beamer, blackboard
Literature
Fischer, R.: Elektrische Maschinen, Hanser-Verlag, 17th edition, 2017 Kremser, A.: Elektrische Maschinen und Antriebe, Springer Verlag, 5th edition, 2017 Binder, A.: Elektrische Maschinen und Antriebe, Springer Verlag, 2nd edition, 2017 Hagl, R.: Elektrische Antriebstechnik, Hanser-Verlag, 4th edition, 2024 Brosch, P.: Drive practice: Energy-efficient drive systems with fixed or variable speed, Vogel Verlag, 1st edition, 2017 Hughes, A., Drury, B.: Electric Motors and Drives, Elsevier, 5th Edition, 2019
Further information on the course
Documents English, teaching language is German or English depending on students. It is not guaranteed that the course can be offered in every semester according to the frequency. Please compare the curriculum table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Selected Topics in Control Engineering (Selected Topics in Control Engineering)		
Person responsible for the module	Faculty	
Prof Dr Claus Brüdigam	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Control engineering

Assigned submodules:

No.	Designation of the sub-modules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Selected chapters of the Control engineering	4 SWS	5

Submodule	**TM abbreviation**
Selected chapters of control engineering	**ASR**

Person responsible	Faculty
Prof Dr Claus Brüdigam	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Claus Brüdigam	only in the winter semester
Teaching form	
Seminar-based teaching with practical work in the laboratory	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up time, Exam preparation: 90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Modelling (e.g. of an autonomous vehicle) • Controller design (root locus method) and discrete-time realisation on a microcontroller (e.g. for an autonomous vehicle) • System description in the state space • Controllability/observability • Controller design with complete state feedback (pole specification and Riccati design) • Observer design (Luenberger observer, Kalman filter) • PI state controller • Discrete-time system description • Realisation of discrete-time standard and observer controllers on microcontrollers
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • be familiar with the basic ideas of state space representation, state control (pole specification and Riccati design), observer design (Luenberger observer and Kalman filter) and discrete-time system description (1) • be able to model technical systems (2) • apply the acquired knowledge to controller and observer design for microcontroller systems (3)

Learning objectives: Personal competence
After successfully completing the sub-module, students are able to master at least 50% of the specialised content. Personal skills are taught indirectly in the course, e.g. when formulating questions and concerns or completing laboratory appointments, which generally trains interaction with other people (e.g. fellow students and lecturers). Preparing for the exam teaches students to plan conscientiously and prepare thoroughly. However, these competences are not specifically tested.
Training materials offered
Help sheets, exercises, Matlab tutorial, microcontroller development environment, sample programmes
Teaching media
Blackboard, projector, PC workstation with Matlab/Simulink, laboratory set-ups
Literature
G. Schulz: Control engineering 2 (multivariable control, digital control engineering, fuzzy control) regulation). Oldenbourg Publishing House Munich O. Föllinger: Linear scanning systems. Oldenbourg Publishing House, Munich H. Unbehauen: Regelungstechnik II - Zustandsregelungen, digitale und nicht¬lineare Regelsysteme. Vieweg Verlag, Braunschweig J. Lunze: Regelungstechnik 2 - Mehrgrößensysteme, Digitale Regelung: Springer Verlag, Berlin E.-G. Feindt: Regeln mit dem Rechner, Abtabregelungen mit besonderer Berück-sichtigung der digitalen Regelungen. Oldenbourg Publishing House Angermann, Beuschel, Rau, Wohlfarth: Matlab - Simulink - Stateflow. Oldenbourg Publishing House Munich R. Marchthaler, S. Dingler: Kalman-Filter - Einführung in die Zustandsschätzung und ihre Anwendung für eingebettete Systeme, Springer Vieweg, Wiesbaden J. Wendel: Integrated Navigation Systems - Sensor Data Fusion, GPS and Inertial Navigation, Oldenbourg Verlag, Munich, Vienna
Further information about the course
• Maximum 18 participants • It is not guaranteed that the course can be offered in every semester according to the frequency. Please compare the curriculum table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Coding in the transmission of information (Coding for Information Transmission)		
Person responsible for the module	Faculty	
Prof Dr Peter Kuczynski	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
1st study section

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Coding in the Information transfer	4 SWS	5

Submodule		**TM abbreviation**
Coding in the transmission of information		**CI**
Person responsible	Faculty	
Prof Dr Peter Kuczynski	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Peter Kuczynski	only in the summer semester	
Teaching form		
Seminar-based teaching, 10-30% exercises, practical experiments		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Introduction to the basics of probability theory • Basic concepts of information theory (e.g. entropy, redundancy, transinformation) and their meaning • Discrete and continuous sources of information • Transmission channels (e.g. DMC, AWGN) • Maximum likelihood decision • memorised and non-memorised sources of information • First-order Markoff source • Source coding (selected examples and procedures) • Huffman coding • Channel coding and decoding (selected examples and procedures) • Hamming distance, linear code • Hamming codes, cyclic codes, convolutional codes • Channel capacity (definition, meaning, calculation, examples) • Shannon's main sentences • Practical exercises with the help of MATLAB

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • apply and evaluate basic methods of source coding (3) • apply and evaluate basic methods of channel coding and channel decoding (3) • understand and apply the basics of probability theory (2) • Basic concepts of information theory to understand and perform and evaluate selected calculations (e.g. entropy) (3) • to model and evaluate sources with and without memory (3) • model and evaluate basic discrete and continuous transmission channels (3) • understand the definition of channel capacity and perform and evaluate selected calculations of channel capacity (3) • understand and apply optimal decision-making procedures (2) • realise selected source and channel coding methods using MATLAB and evaluate the results of MATLAB simulations (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Scripts, exercises, bibliography
Teaching media
Overhead projector, blackboard, computer/beamer
Literature
Firoz Kaderali: Digital Communication Technology I, Vieweg 1995
Further information about the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Humans in a technological world: innovation, ethics and Responsibility, Sustainability (Human Beings in a Technological World: Innovation, Ethical Responsibility, Sustainability)		
Person responsible for the module	Faculty	
Prof Dr Thomas Kriza	Applied natural and cultural sciences	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	The human being in a technical World: Innovation, ethical responsibility, sustainability	4 SWS	5

Submodule		**TM abbreviation**
Humans in a technological world: innovation, ethics and Responsibility, sustainability		**MTW**
Responsible person	Faculty	
Prof Dr Thomas Kriza	Applied natural and cultural sciences	
Teacher / Lecturer	Offer frequency	
Prof Dr Thomas Kriza	in each semester	
Teaching form		
Seminar-based teaching		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	50 h preparation and follow-up, 44 h Exam preparation

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
The technology ethics course addresses the dynamics of modern technology, the Possibilities of an ethically responsible approach to technology and the ethical principle of sustainability. In particular, the following topics are addressed: • individual innovative, dynamic fields of technology such as digitalisation (with aspects such as artificial intelligence and big data), renewable energies, biotechnology, etc. • the general modes of action of the (modern) technology and the underlying thought patterns. • the intended and unintended consequences of a globalised way of life characterised by the use of technology. • the defining cultural images of man, values and horizons of meaning of the present. • the ethical responsibility of people when dealing with technology. • Sustainability as a comprehensive ethical principle and a central challenge of the present. The selection of examples and fields of application will be directly related to the participants' field of study.

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Know important innovative and "disruptive" technologies (1) and understand the core of how they work (3). • develop a deeper understanding of the general dynamics of modern technology (3). • know basic cultural values and concepts of humanity (1) and ethically assess the potential of innovative technologies against this background (3). • understand the basic idea of ethics and ethical responsibility in contrast to (natural) scientific provability and technical feasibility (2). • to develop an understanding of sustainability as a comprehensive ethical principle and as a central challenge of the present (3). • analyse the ethical pursuit of greater sustainability, the search for technical and non-technical solutions and the contradictions that arise in the process on the basis of specific use cases (3).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • reflect independently and critically on the seminar topics, adopt their own ethical positions and justify them to others (3). • develop an awareness of ethically responsible behaviour in dealing with technology in open discussions with others (3). • acquire knowledge independently and on their own responsibility from suitable sources, including English-language specialised literature, and thus prepare for the performance assessment (3). • acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
z. e.g. presentations, texts
Teaching media
z. e.g. blackboard, projector
Literature
• Jonas, H. (1993). Why technology a subject for ethics: Five reasons. In H. Lenk & G. Ropohl (eds.), Technology and Ethics (pp. 81-91). Stuttgart: Philipp Reclam jun. • Harari, Y. (2017). Homo Deus. A history of tomorrow. Munich: C.H. Beck. • Heinrichs, H. & Michelsen, G. (eds.). (2014). Sustainability Sciences. Berlin: Springer Spektrum. Further literature will be announced in the course.
Further information on the course
The module is offered by the Regensburg School of Digital Sciences (RSDS) and is therefore limited to 20 participants for students of the Faculty of Electrical Engineering and Information Technology.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Digital Electronics	

Person responsible for the module	Faculty
Prof Dr Florian Aschauer	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Knowledge of digital technology lecture

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Digital electronics	4 SWS	5

Submodule		**TM abbreviation**
Digital electronics		**EN**
Responsible person	Faculty	
Prof Dr Florian Aschauer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Florian Aschauer	only in the summer semester	
Teaching form		
Seminar-based teaching, exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
CMOS basic circuits combinatorial • Inverter, NAND, NOR, Complex Gates CMOS basic circuits sequential • Latch, D flip-flop, register, shift register, various universal registers Bipolar basic circuits combinatorial • Basic principle of ECL circuit technology, OR/NOR Complex basic functions; adder, multiplier • Half adder, full adder, carry look ahead • Realisation of the adder stages as complex gates • Ripple carry multiplier, carry-save multiplier, serial multiplier State machines • Moore- Mealy machine • Draft via status table • Design via state diagram • Design with hardware description languages Introduction to the hardware description language VHDL • Concurrent and sequential language elements • Coding examples of the basic blocks Systematic design of complex digital systems • Register planning • Timing planning with spreadsheet • Application example RS232 interface - Application example SPI interface
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • indicate the basic circuits of digital microelectronics (1) • name the basic blocks of complex systems (1) • carry out the circuit design of digital circuits on an FPGA or ASIC basis (2) • generate the system design of digital circuits on an FPGA or ASIC basis (2) • systematically design complex digital systems at gate and register transfer level with the aid of hardware description languages (3) • assess the feasibility of digital systems (3) • divide complex projects into sub-projectsdefine sub-specifications and interfaces (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, sample solutions, bibliography, simulation models
Teaching media
Interactive cloze script with computer/beamer, blackboard, simulation software
Literature
Weste, Eshragian: "Principles of CMOS VLSI Design, A Systems Perspective", Massachusetts: Addison-Wesley 1993 Wakerly, John F.: "Digital Design, Principles and Practices",New Jersey:Prentice Hall 2005Mano, M. Morris : "Computer System Architecture",New Jersey: Prentice Hall 1993 Hodges, D. A., Jackson, H. G.: "Analysis and Design of Digital Integrated Circuits", New York: McGraw Hill 2003 Mead, C., Conway,L.: "Introduction To VLSI Systems",Massachusetts:Addison-Wesley 1980 Klar, H.: "Integrierte Digitale Schaltungen MOS/BICMOS", Springer Verlag:Berlin 1996 Navabi, Zainalabedin : "VHDL Analysis and Modeling of Digital Systems", New York: McGraw Hill 1993
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Digital Signal Processing		
Person responsible for the module	Faculty	
Prof Dr Armin Sehr	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Signals and systems

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Digital signal processing	4 SWS	5

Submodule	TM abbreviation
Digital signal processing	**DSV**

Person responsible	Faculty
Prof Dr Armin Sehr	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Andreas Maier Prof Dr Armin Sehr	only in the summer semester
Teaching form	
approx. 50% seminar-based teaching, approx. 50% practical training	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Discrete-time signals and systems • Design of digital filters • Discrete Fourier transform and frequency analysis • Analogue-to-digital and digital-to-analogue conversion • Practical implementation with the help of a simulation tool
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • various realisations of linear time-invariant (LTI) systems systems (2). • describe discrete-time signals and systems in the time, frequency and image domain (2). • properties of different digital filters (2). • spectra of discrete-time signals (3). • carry out a frequency analysis with the help of a simulation tool such as Matlab (3) and recognise problems (2). • to convert different forms of description for LTI systems into one another (3). • implement signal processing algorithms with the help of a simulation tool (3) and to evaluate (3).

• derive a specification for a digital filter from a task (3) and then use a simulation tool to design the filter (3). • analyse specific signal processing problems (3) and solve them with the help of a simulation tool (3). • recognise which problems can be solved with digital signal processing (3).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Lecture slides, exercises, practical tasks
Teaching media
Blackboard, beamer, Matlab
Literature
Oppenheim, Schafer, Buck: Discrete-time signal processing, Pearson Proakis, Manolakis: Digital Signal Processing, Pearson Werner: Signals and Systems, Vieweg Springer Werner: Digital Signal Processing with Matlab, Vieweg Springer
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Digitalisation and ethics		
Person responsible for the module	Faculty	
Prof Dr Thomas Kriza	Applied natural and cultural sciences	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Mandatory requirements
The course cannot be attended if the course *"The People in a technical world: innovation, ethical responsibility, sustainability"* was completed.

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Digitalisation and ethics	4 SWS	5

Submodule		**TM abbreviation**
Digitalisation and ethics		**THE**
Person responsible	Faculty	
Prof Dr Thomas Kriza	Applied natural and cultural sciences	
Teacher / Lecturer	Offer frequency	
Prof Dr Thomas Kriza	in each semester	
Teaching form		
Seminar-based teaching		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	40 h preparation and follow-up, 20 h Exam preparation

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
The course focuses on the *technical developments of digitalisation* and the *the social changes and ethical issues* associated with it. In particular, the following topics are addressed: • Technical aspects of digitalisation: including artificial intelligence, big data analyses, social media, smart homes, virtual reality, digitalised medical and biotechnology, ... • Effects of digitalisation on society, the individual and the professional world: including human relationships and communication in social media, personalised (election) advertising, living and working in Industry 4.0, the "transparent" person/citizen/patient, ... • Ethical questions of digitalisation: including "What is the significance of privacy and data protection in a digital world?", "How can we benefit from the technical developments of digitalisation as free and self-determined individuals with inviolable human dignity?" • the defining cultural images of man, values and horizons of meaning of the present as well as the thought patterns associated with the dynamics of modern technology The selection of examples and fields of application will be directly related to the participants' field of study. No special technical knowledge is required. **Important note:** The course cannot be taken if the course *"Man in a Technical World: Innovation, Ethical Responsibility, Sustainability"* has already been completed.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know key technical aspects of digitalisation (1) and understand the core of how it works (3). • assess the impact of digitalisation on society and on people's individual and professional lives in specific cases, keeping an eye on both the potential and the risks of technology (2). • know basic cultural values and concepts of humanity (1) and assess the technical potential of digitalisation ethically against this background (3).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • understand central ethical and philosophical questions of digitalisation and take their own reflected ethical positions and justify them to others (3). • develop an awareness of ethically responsible behaviour in dealing with the technical possibilities of digitalisation in open discussions with others (3). • acquire knowledge independently and on their own responsibility from suitable sources, including English-language specialised literature, and thus prepare for the performance assessment (3). • See also the introduction to this module handbook, point 2.
Training materials offered
z. e.g. presentations, texts

Teaching media
z. e.g. blackboard, projector
Literature
• Shanahan, M. (2015). The Technological Singularity. Cambridge: MIT Press. • Harari, Y. (2017). Homo Deus. A history of tomorrow. Munich: C.H. Beck. • Greenwald, G. (2014). Global surveillance. The Snowden case, the American secret services and the consequences. Munich: Droemer. • Kosinski, M., Stillwell, D. & Graepel, T. (2013). Private traits and attributes are predictable from digital records of human behaviour. PNAS, 110 (15), PP. 5802-5805. => -Further literature will be in the course.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Real-Time Signal Processing		
Person responsible for the module	Faculty	
Prof Dr Armin Sehr	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Signals and systems

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Real-time signal processing	4 SWS	5

Submodule	TM abbreviation
Real-time signal processing	**ESV**

Responsible person	Faculty
Prof Dr Armin Sehr	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Armin Sehr	only in the winter semester

Teaching form
approx. 50% seminar-based teaching, approx. 50% practical training on the computer

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Fixed-point arithmetic and floating-point arithmetic
- Filter structures
- Effect of quantisation and calculation inaccuracies on FIR and IIR filters
- Statistical signal processing
- Increased efficiency in signal processing algorithms
- Implementation of signal processing algorithms in real-time applications
- Programming of signal processing algorithms on a digital signal processor (DSP)

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to
- list the advantages and disadvantages of fixed and floating point arithmetic (1) and select the appropriate option depending on the problem (3).
- name the different filter structures (1) and convert them into each other (3).
- understand (2) and assess (3) the impact of quantisation and computational inaccuracies on FIR and IIR filters.
- describe (2) and analyse (3) statistical signals in different ways.
- Consider the special features of real-time signal processing when implementing systems (3).
- Putting a system with a digital signal processor (DSP) into operation (3).

- signal processing algorithms in real-time applications (3), on a DSP (3) and to verify the correct function (3).
- independently analyse problems (3) and convert specifications into a real-time implementation (3).
- Systematically search for errors (3).
- assess different solutions in terms of functionality, development effort and costs (3)
- systematically design software to solve signal processing problems

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook). additionally: After successfully completing the module, students will be able to work purposefully in a team to solve a problem and distribute the different roles in a team sensibly.

Training materials offered
Lecture slides, experiment instructions, sample programmes

Teaching media
Computer, projector, blackboard, experimental setups with DSP board

Literature
• M. Werner: Digital Signal Processing with Matlab, Springer Vieweg 2012 • A. Oppenheim et al: Discrete-Time Signal Processing, Pearson 2014 • D. Reay: Digital Signal Processing and Applications with the OMAP-L138 eXperimenter, Wiley 2012 • T. Welch et al: Real-Time Digital Signal Processing from Matlab to C with the TMS320C6x DSPs, CRC Press 2012

Further information about the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Real-Time Systems		
Person responsible for the module	Faculty	
Prof Dr Norbert Balbierer	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Microcomputer technology (ARM Cortex-M basics) Computer science I (C programming)

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Real-time systems	4 SWS	5

Submodule	**TM abbreviation**
Real-time systems	**ES**

Responsible person	Faculty
Prof Dr Norbert Balbierer	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Norbert Balbierer	only in the summer semester

Teaching form
Seminar-based teaching, laboratory exercises, proportion of exercises> 10 %

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up: 75 h Exam preparation: 15 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Definition of real time and timeliness - Hardware support: • Timer • DMA, interrupts • I/O with interrupt synchronisation • FIFOs - Real-time operating systems using the example of FreeRTOS • Multithreading • Message queues, mutexes and semaphores • Driver interfaces - Input and output in real-time computer systems - Communication interfaces • Examples: UART, CAN, Ethernet, SPI and I2C • Time synchronisation between embedded systems - Lecture examples with ARM Cortex-M4 processor and RTOS operating system

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • ... understand the concept of real-time capability and be able to derive requirements for hardware and software (1). • ... to estimate the influence of hardware and software operations on real-time capability (2). • ... Designing embedded systems using hardware in a computing time-optimised and real-time capable manner (e.g. through timers, interrupt synchronisation and DMA, sensible memory usage, ...) (3) • ... use I/O interfaces of embedded systems to communicate with external peripherals or other systems (e.g. UART, SPI, I2C) (2) • ... Multithreading on a microcontroller with real-time operating system (RTOS) (2) • ... understand the functionality of an RTOS (using the example of FreeRTOS) and its dependencies on the underlying hardware (memory, timer, CPU, ...) (2). • ... Understand synchronisation mechanisms and access to shared resources in multithreaded operating systems and be able to use them correctly and efficiently in software development (2) • ... know the basics of network and bus communication in distributed, embedded systems (1) • ... to use the CAN bus for synchronisation and data transfer between several embedded systems.
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • ... be able to work with other RTOS-based SDKs and software environments (e.g. ESP-IDF) (3) • ... to deal with (partly English) specialised vocabulary (1) • ... develop a systematic view of larger embedded software systems (2) • ... develop a feel for time sequences and interrelationships in software and hardware (1)
Training materials offered
Scripts, English reference manuals (ARM Cortex-M), textbooks, RTOS source code
Teaching media
Computer / projector, blackboard, evaluation boards and logic analyser, webcam
Literature
• J. Valvano, Introduction to ARM Cortex-M Microcontrollers Vol. 2, 2015 • J. Yiu,The Definitive Guide to the ARM Cortex-M3 , Elsevier 2010 • F. Graf, Automation Systems, Script, OTH Regensburg • N. Balbierer, Echtzeitsysteme, Script (in progress), OTH Regensburg • ARM, ARM Cortex-M4 Technical Reference Manual, company publication • A. S. Tanenbaum, Modern Operating Systems, Pearson • J. J. Labrosse, Uc/OS-III: The Real-Time Kernel and the Freescale Kinetis Arm Cortex- M4, Micrium, 2011

Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Electrical power distribution with practical training (Electrical Power Distribution with Lab Course)		EVP
Person responsible for the module	Faculty	
Prof Dr Franz Fuchs	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Lecture Electrical Energy Networks/Electrical Systems Engineering

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Electrical power distribution	2 SWS	2.5
2.	Electrical internship Energy distribution	2 SWS	2.5

Submodule	**TM abbreviation**
Electrical power distribution	**EV**

Person responsible	Faculty
Prof Dr Franz Fuchs	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Franz Fuchs Prof Dr Matthias Haslbeck Andreas Schmidt (LB)	only in the summer semester

Teaching form
Seminar-based teaching: 10-15% exercise component Supplementary offer: Practical course in electrical power distribution

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2.5

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 32 h Exam preparation: 15 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Basics of mains protection technology • Star point and earth fault treatment in three-phase systems • High-voltage three-phase current transmission • Power flow in the three-phase grid
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • To know the functionality and possible applications of mains protection devices (2) and, in particular, to carry out the design and parameterisation of digital distance protection devices (3) • assess the risks and effects of a single-pole earth fault (3) and investigate the influence of neutral point treatments on the fault (3) • Determine the transmission behaviour of high-voltage transmission lines analytically (3)

- Know the basics of numerical power flow calculation (2) and perform numerical power flow calculations (3)

Upon successful completion of the module, students receive:

- Knowledge of basic interrelationships in electrical energy supply (2)
- Knowledge of protection technology in electrical power transmission systems (2)
- Knowledge of the occurrence and handling of faults in energy transmission networks (2)
- Knowledge of the behaviour and operation of high-voltage transmission lines (2)
- Sound knowledge of various methods of power flow calculation (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Bibliography, presentation slides, exercises
Teaching media
Blackboard, computer/beamer
Literature
Flossdorf R., Hilgarth G.: Elektrische Energieverteilung, Vieweg+ Teubner, 2005 Kniess,W; Schierack,K: Elektrische Anlagentechnik, Verlag Hanser, 2012 Oeding, D.; Oswald,B.: Elektrische Kraftwerke und Netze, 8th edition 2016, Berlin, Springer Verlag Heinhold, L.: Kabel und Leitungen für Starkstrom, Verlag Publicis MCD, 5th edition, 1999 Heuck, K.; Dettmann, K.-D.: Elektrische Energieversorgung, Verlag Springer, 9th edition, 2013 Schwab, A.J.: Elektroenergiesysteme - Smarte Stromversorgung Im Zeitalter der Energiewende.Springer Vieweg. in Springer Fachmedien Wiesbaden GmbH, Berlin, Heidelberg, 2020.
Further information about the course
It is not guaranteed that the course will be offered in every semester according to frequency can be offered. To do this, please compare the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		TM abbreviation
Internship Electrical Power Distribution		**PEV**
Person responsible	Faculty	
Prof Dr Franz Fuchs	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Franz Fuchs Prof Dr Matthias Haslbeck Andreas Schmidt (LB)	only in the summer semester	
Teaching form		
Laboratory internship		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2.5

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up of the experiments: 32 h, Preparation of performance record: 15 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Practical experiments on • Charging current, earth fault current and earth fault current compensation • Digital distance protection for cables • Power flow calculation in meshed networks • Operating behaviour of a very long high-voltage line • Behaviour of cables and windings with Surge stresses (travelling waves)
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • to recognise the dangers and effects of a single-pole earth fault and to counteract these by means of earth fault current compensation. (3) • Know the functionality and possible applications of digital distance protection devices and parameterise them (3) • Perform simulations of operating states of electrical energy networks (3) • The behaviour of long high-voltage lines under different operating conditions (3)

Upon successful completion of the module, students receive: • Basic knowledge of the operating modes and protective devices of networks (2) • In-depth knowledge of the function and application of components, systems and networks in electrical power distribution (3) • In-depth knowledge of phenomena occurring during the operation of networks (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Instructions for the individual experiments
Teaching media
Test set-ups, electronic measurement protocols, programme for power flow calculation
Literature
Flossdorf, Hilgarth: Elektrische Energieverteilung, Vieweg+Teubner, 2005 Kniess,W; Schierack,K: Elektrische Anlagentechnik, Verlag Hanser, 2012
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Electrical Machines (Electrical Machines)		
Person responsible for the module	Faculty	
Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Mandatory requirements
Lecture Electrical energy converters
Recommended prior knowledge
1st study section

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Electrical machines	2 SWS	3
2.	Internship Electrical Machines	2 SWS	2

Submodule	TM abbreviation
Electrical machines	**EM**

Responsible person	Faculty
Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Bernhard Hopfensperger	in each semester

Teaching form
Seminar-based teaching, 10-15% exercises Supplementary practical course in electrical machines

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	3

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 38 h, Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Repetition Structure, mode of operation and stationary operating behaviour of electrical machines (direct current, synchronous and asynchronous machines) based on the electrical energy converter (EW) module. Advanced and in-depth operating behaviour of the three machine types: • DC machine (field weakening operation, series connection machine) • Synchronous machine (open circuit, short circuit, mains operation, special designs) • Asynchronous machine (speed adjustment, current locus curve) • Fundamentals of thermal behaviour and design of electrical machines.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • explain the design and operating behaviour of the three basic machine types (1), • explain the influence of torque and speed on the machine types (1) and evaluate the respective application possibilities (3), • to perform steady-state operating point calculations (2), • thermal calculations on the 1-body model (2),

- carry out a design assessment depending on torque and size (3),
- Perform calculations on the current locus curve for the three-phase synchronous machine and the three-phase asynchronous machine (2).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Slides, supplementary sheets, exercises
Teaching media
Blackboard, calculator, animations
Literature
Fischer, R. - Electrical machines, Hanser Verlag Fuest, K.; Döring, P. - Elektrische Maschinen und Antriebe, Springer / Vieweg+Teubner Verlag Farschtschi, A. - Elektromaschinen in Theorie und Praxis, VDE Verlag Spring, E. - Electrical Machines, Springer Verlag Kremser, A. - Electrical machines and drives, Springer Verlag
Further information about the course
It is not guaranteed that the course will be offered in every semester according to can be offered with the same frequency. Please compare the curriculum table valid for the respective semester

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	TM abbreviation
Internship Electrical Machines	**PEM**

Person responsible	Faculty
Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology
Teacher / Lecturer	**Offer frequency**
Prof Dr Franz Fuchs Prof Dr Bernhard Hopfensperger	in each semester

Teaching form
Laboratory internship

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 20 h, Exam preparation: 12 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

Carrying out four practical experiments:

- Three-phase asynchronous machine with slip ring rotor
- DC machine (separately excited GM and series machine)
- Experimental parameter determination of a squirrel-cage asynchronous machine
- Three-phase synchronous machine / synchronous generator

Preparation of experimental work and presentation on the implementation and results of an experiment.

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- carry out stationary operating point measurements on the three machine types (2) and analyse the data (2),
- to use electrical power in a safety-conscious manner (2) and to assess potential risks (2),
- a comprehensible documentation of the measurement results to create (2) and to evaluate measurement results with regard to their meaningfulness (3),

• in the framework a presentation the experimental procedure and measurement results (2).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Tasks, structure description, script, exercises, bibliography
Teaching media
Flip charts, cut-open machine models, experimental set-ups
Literature
Fischer, R. - Electrical machines, Hanser Verlag Fuest, K.; Döring, P. - Elektrische Maschinen und Antriebe, Springer / Vieweg+Teubner Verlag Farschtschi, A. - Elektromaschinen in Theorie und Praxis, VDE Verlag Spring, E. - Electrical Machines, Springer Verlag Kremser, A. - Electrical machines and drives, Springer Verlag
Further information about the course
It is not guaranteed that the course will be offered in every semester according to can be offered with the same frequency. To do this, please compare the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Embedded Communication Networks		
Person responsible for the module	Faculty	
Prof Dr Norbert Balbierer	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
C or Python

Assigned submodules:

No.	Designation of the sub-modules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Embedded Communication Networks	4 SWS	5

Submodule		**TM abbreviation**
Embedded Communication Networks		**ECN**
Responsible person	Faculty	
Prof Dr Norbert Balbierer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Norbert Balbierer	only in the winter semester	
Teaching form		
seminar lessons, exercises 10%-30%		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Layer models; basics of networked communication - Data transmission • Duct model, line and duct coding • Modulation method • Shannon's theorem, bandwidth and signal-to-noise ratio - Data link networks • Frame formation, error detection • Multiplexing and media access method (MAC) • Troubleshooting (ARQ) - Ethernet • History, variants, development • Ethernet physical layer (Ethernet PHY) • Ethernet backup slot (MAC, LLC) • Switches and virtual LANs - 802.11 Wireless LAN • Architecture of 802.11 (physical and in the 802 model) • Wireless radio standards and procedures (DSSS, OFDM) • Spatial Diversity and Spatial Multiplexing (MIMO) - Outlook for higher layers, TCP/IP - Programming of network applications in C and/or Python on embedded hardware (Raspberry Pi, ESP32, STM32H743 or similar) • Socket API • Client-server models • Publish-subscribe protocols (MQTT as an example) • "Home automation" with MQTT and Python
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • ... understand the basics of modern communication technology (transmission technology, coding and modulation methods, error correction) (2) • ... Have a comprehensive understanding of LAN technologies (Ethernet, WLAN) in the context of embedded systems (2) • ... know different types of topologies and media access methods (1) and understand their special features and areas of application (2) • ... understand the functionality and structure of Ethernet switches and be able to classify the effects on time behaviour, packet losses, etc. (2) • ... Record and analyse network traffic (Wireshark) (2) • ... Set up and configure local networks with embedded systems (1) • ... Know important protocols of the Internet protocol family (1) and understand their properties and areas of application (2)

- ... Programming network applications on embedded systems (socket API) (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • ... to deal with (partly English) specialised vocabulary (1) • ... operate your own networks (e.g. at home) (3) • ... have a feel for the network technologies used on the Internet (2) • ... develop an understanding of the relationships between embedded systems, hardware and networks (1)
Training materials offered
Scripts, textbooks, sample programmes in C and Python
Teaching media
Computer/projector, whiteboard, WLAN and Ethernet-capable hardware (ESP8266, STM32, Raspberry Pi, switches, access points)
Literature
Andrew S. Tanenbaum, Computer Networks, Pearson James Kurose & Keith Ross, Computer Networks: The Top-Down Approach, Pearson
Further information about the course
It is not guaranteed that the course will be offered in every semester according to can be offered with the same frequency. To do this, please compare the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
EMC compliant PCB and system design (EMC compliant) PCB and System Design)	

Person responsible for the module	Faculty
Prof Dr Thomas Stücke	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Use of Matlab, LTSpice, HFSS (FEM field simulations), Eagle (PCB layout) helpful but not absolutely necessary

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	EMC-compliant printed circuit board and System design	4 SWS	5

Submodule		**TM abbreviation**
EMC-compliant PCB and system design		**ELE**
Person responsible	Faculty	
Prof Dr Thomas Stücke	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Thomas Stücke	only in the winter semester	
Teaching form		
Seminar-based teaching, exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up: 60 h Exam preparation 30 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Basics of EMC
- EMC planning for the system and on the printed circuit board (PCB)
- EMC equivalent circuit diagrams of components
- Design rules: General, for digital and analogue circuits
- EMC measures in the PCB layout (ground and signal structures, blocking)
- Application of field simulations to analyse couplings
- Circuit simulations for EMC optimisation (LTSpice)
- System calculations and numerical evaluation of simulation data with Matlab and Excel
- Realisation of layout adjustments

Note: The aim of the course is to be able to design and assess an EMC-compliant system / printed circuit board. The entire "design flow" should be considered. The software used is therefore only applied / used without comprehensive training in these programmes.

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- describe the basic principles of EMC, explain the different types of coupling, differentiate between internal and external EMC and classify the causes of electromagnetic incompatibility (2)
- EMC equivalent circuit diagrams of components and cables and thus predict the behaviour of circuits (2)
- distinguish between balanced and unbalanced circuits and explain the effects of common-mode and differential-mode interference on them (2)
- explain the formation and effects of electrostatic discharge (ESD), including the effect of secondary discharge (2)
- Correct cable and enclosure shielding and correct arrangement of printed circuit boards in enclosures (3)
- Select suitable ESD and surge protection elements, connect them correctly and design staggered protection (3)
- describe the challenges of coexistence, select favourable CLK frequencies and carry out systematic crosstalk analyses (3)
- to create an EMC-suitable separation of individual supply voltage levels and to design the supply networks and earth on the PCB in an EMC-suitable manner (3)
- implement suitable circuitry measures to improve EMC for analogue and digital circuits (3)
- Differentiate between Spice, 2.5D and 3D field simulation software and select the appropriate one for the problem (2)

Learning objectives: Personal competence

After successfully completing this sub-module, students will be able to
acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).

Training materials offered

Slides and sample files

Teaching media

Projector, blackboard, computer in the CIP pools

Literature

Franz: EMC - interference-free design of electronic circuits. Springer Publishing House, 2013
Durcansky: EMC-compliant device design. Franzis Publishing House, 1999
Gustrau, Kellerbauer: Electromagnetic compatibility. Hanser Publishing House, 2015

Further information on the course

- Previous knowledge of the following software is helpful, but not mandatory
  necessary: Matlab, LTSpice, HFSS (FEM field simulations), EAGLE (PCB layout)
- It is not guaranteed that the course can be offered in every semester according to the frequency. Please compare the curriculum table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Energy storage (Energy Storage)		
Person responsible for the module	Faculty	
Prof Dr Michael Sterner	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Physics, Maths 1 and 2, Fundamentals of Electrical Engineering 1 and 2, Engineering Mechanics, Materials science

Assigned submodules:

No.	Designation of the sub-modules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Energy storage	4 SWS	5

Submodule		TM abbreviation
Energy storage		**ENS**
Person responsible	Faculty	
Prof Dr Michael Sterner	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Michael Sterner	only in the winter semester	
Teaching form		
Seminar-based teaching with approx. 10-20 % exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up: 60 h; Exam preparation: 30 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Energy storage in the course of time
- Definition and classification of energy storage systems
- Storage requirements in the power supply
- Storage requirements in the heat supply
- Storage requirements in the transport sector
- Electrical energy storage
- Electrochemical energy storage
- Chemical energy storage
- Mechanical energy storage
- Thermal energy storage
- Load management as energy storage
- Comparison of storage systems
- Storage integration in individual energy sectors
- Storage integration for coupling different energy sectors

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- know the definition and efficiency calculations of energy storage systems (1) and apply them (3)

- to know the status of the discussion on the need for storage (1)
- analyse the properties of the most important energy storage systems (3) and work out their integration into energy systems (2)
- calculate the most important technical and economic storage sizes (2)
- Designing energy storage systems for different applications (3)
- estimate and analyse the potentials, sizes and classifications of energy storage systems (3) and
- to know the integration possibilities for energy storage in sector coupling (1)

Learning objectives: Personal competence

After successfully completing this sub-module, students will be able to

- organise and work in a team (2)
- ask technical questions (3) and reproduce technical contexts in correct technical language (3)
- conduct critical discussions in an objective atmosphere (2)
- to deal constructively with different views and criticisms (3)
- assess the importance of careful, independent work for your learning success (3)
- Recognise the difference between understanding and simply applying solutions and take advantage of both approaches (3)
- to know the principles of good scientific practice (1) and
- be able to deal with scientific literature (2)

Training materials offered

Specially prepared book for the lecture in German and English, exercises with solutions, data sheets, videos, bibliography

Teaching media

Blackboard, computer/beamer, book chapter

Literature

- Sterner Michael and Ingo Stadler: Energy storage - demand, technologies, integration
  ISBN 978-3-642-37380-0; Springer-Verlag Heidelberg Berlin, 2017
    - Jossen, Weydanz: Using modern accumulators correctly, 2006

Further information on the course

If required, the course will be held in English.

It is not guaranteed that the course can be offered in every semester according to the frequency. Please compare the curriculum table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Entrepreneurship and Innovation Management (Entrepreneurship and Innovation Management)		
Person responsible for the module	Faculty	
Prof Dr Sean Patrick Saßmannshausen	Business and Management	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
The course is aimed at students in engineering sciences who are explicitly not business management requirements.

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Entrepreneurship and Innovation management	4 SWS	5

Submodule	TM abbreviation
Entrepreneurship and innovation management	**EIM**

Person responsible	Faculty
Prof Dr Sean Patrick Saßmannshausen	Business and Management
Teacher / Lecturer	**Offer frequency**
Prof Dr Sean Patrick Saßmannshausen	only in the summer semester

Teaching form
Seminar-based teaching with approx. 20% exercises and case studies

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	94 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
The content of the course essentially deals with entrepreneurship (entrepreneurship, business start-ups), intrapreneurship (entrepreneurial employees), corporate entrepreneurship and creativity and innovation management. - Part I: Basics: • Innovation theory and innovation models, red queen theory • The importance of innovation and economic development and socio-economic change • Innovation competition: Germany in global comparison • Epistemological and biopsychological foundations of creativity and innovation • Planned and unplanned obsolescence • Psychological, sociological and motivational aspects of entrepreneurs and intrapreneurs and their practical and operational significance - Part II: Creativity and innovation management • Corporate promotion of creativity and innovation • Innovation management and innovation processes • Functions and actors of innovation management, promoter model • Creativity techniques, creativity in teams and in companies - Part III: Entrepreneurship, intrapreneurship and corporate entrepreneurship • Start-up management, entrepreneurship and lean start-ups • Lean Start-up Methodologies (Toolkit) • Corporate Entrepreneurship, Entrepreneurial Orientation and Intrapreneurship • Organisational and evolutionary perspectives on innovation - Part IV: Innovation portfolios, evaluation, selection, management and utilisation • Strategic innovation and technology management • Management, evaluation and selection of innovation projects • Market Opportunity Navigator • Ethical aspects of innovation management • Market launch management and product management • Fundamentals of production management of innovative products • Role of industrial industrial property rights, patents, utility and designs, copyrights
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to - Expertise • Students understand the importance of technology and innovation management for companies and their competitive position (2). • They know (1) the epistemological foundations of innovations and understand (2) their significance for interdisciplinary operational communication processes. • Students recognise the overarching importance of innovation for national economies and its dynamics with regard to growth and structural or qualitative changes (1).

- They can establish the connections within global value chains and industrial policy and corporate policy decisions accordingly (2).
- They know the typical characteristics of entrepreneurial personalities and are aware of their importance in the context of setting up and organising a business (1).
- They know (1) creativity processes and their typical operational challenges and can apply appropriate techniques to support them and manage them at team and department level (3).
- Students understand (2) operational innovation systems and the management of innovation processes and portfolios and know how to design such systems (3).
- Students are familiar with corporate entrepreneurship systems and constructs of Entrepreneurial Management and Entrepreneurial Orientation (1), they can apply them to operational situations (3) and know (1) typical obstacles to their establishment.
- Students are familiar with methods of technology utilisation through product launches, new business units, spin-offs and start-ups (1). They know (1) basic concepts of product and production management and how they are linked, can apply methods of product development (3), and are able to critically assess all these concepts and systems holistically in terms of their significance for the strategic management of companies from a corporate management perspective (2).
- Students know (1) the basics of industrial property rights, in particular patent and utility model law and property rights strategies.

- Social competence

- Students are to work in a goal-orientated manner in a team (teamwork skills) and to present their findings and opinions in an appropriate and targeted manner (presentation skills) (3).
- They can present their point of view professionally (argumentation skills) (2).

- Methodological expertise

- Students are able to identify existing company innovation systems and corporate entrepreneurship systems (2), analyse them for weaknesses and optimise (2) or redesign them against the background of the current state of science
(3) (Introduction or reform of corporate innovation systems).
- They know (1) various management methods of innovation and start-up management and master (3) individual and team-orientated creativity techniques.
- You know the Lean Startup methodologies and can apply them (2).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • Students are aware of the consequences of decisions in innovation systems and are able to integrate these into their own judgement (3). • They have self-efficacy conviction (3), constructive problem-solving skills (3), a calculated willingness to take risks (2) and the necessary tolerance of ambiguity (1) for innovation and start-up projects.

Training materials offered
The lecture notes for the course, case studies, supplementary texts and up-to-date seminar documents e.g. from practice or from the (daily) press are made available via the GRIPS learning platform.
Teaching media
Blackboard, whiteboard, projector, case studies, instructional videos and audios, role-play simulations, Presentations, group work. All teaching media can also be used online via Zoom if necessary.

Literature
<u>Compulsory literature:</u> Lecturer's slide script for the course (will be made available as a PDF via GRIPS). All case studies and materials covered in the course (changing, will be made available online via the e-learning platform GRIPS (Moodle)! • Blank, Steve (2013): Why the Lean Start-Up Changes Everything. Harvard Business Review, Vol. 93(5), 64-72. • Gilbert, C. G. / Eyring, M. J., (2010): "Beating the Odds when you Launch a New Venture." Harvard Business Review, Vol. 88(5), 92-98. • Hisrich Robert D.; Peters, M. P.; Shepherd, D. A. (2012): Entrepreneurship. McGraw Hill. (extracts) • Learner, J. (2013): Corporate Venturing. Harvard Business Review, Dec., 86-94. • Onyemah V.; Pesquera, M. R.; Ali, A. (2013): What Entrepreneurs Get Wrong, Harvard Business Review, Vol. 93(5), 74-79. <u>Additional recommended literature:</u> • Adams & Spinelli: New Venture Creation. McGraw Hill. • Albers, Sönke & Gassmann, Oliver (eds.) (2005): Handbuch Technologie- und Innovationsmanagement: Strategie - Umsetzung - Controlling. Heidelberg et al: Springer (e-book). • Allen, K.: Launching new Ventures - An Entrepreneurial Approach. • Baron, R. A.: Entrepreneurship: An Evidence-based Guide. • Baron, R. A., Shane, S. A.: Entrepreneurship: A Process Perspective. • Disselkamp, Marcus (2012): Innovationsmanagement: Instrumente und Methoden zur Umsetzung im Unternehmen. Heidelberg et al: Springer (e-book). • Drucker: Innovation and Entrepreneurship. • Kim, W. C., & Mauborgne, R. (2000). Knowing a winning business idea when you see one. Harvard Business Review, 78(5), 129-138. • Malhotra, D. (2013): How to Negotiate with VCs Harvard Business Review, Vol. 93(5), 84-91. • Mulcahy, D. (2013): Six Myths About Venture Capitalists. Harvard Business Review, Vol. 93(5), 80-83. • Stern, Thomas & Jaberg, Helmut (eds.) (2007): Successful Innovation Management: Success Factors - Basic Patterns - Case Studies. Heidelberg et al: Springer (e-book). • Volkmann, C., Tokarski, K., Grünhagen, M. (2010): Entrepreneurship in a European Perspective-Concepts and Growth of New Ventures. in the current edition.

Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester. The event is part of the joint focus on technology and management.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Generating new energy carriers		
Person responsible for the module	Faculty	
Dr Robert Daschner (LB)	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Teaching content of the first study phase

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Production of new energy sources	4 SWS	5

Submodule	**TM abbreviation**
Production of new energy sources	**ENE**

Responsible person	Faculty
Dr Robert Daschner (LB)	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Dr Robert Daschner (LB)	only in the winter semester
Teaching form	
Seminar-style teaching, proportion of exercises: 10-20%	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 54 h, Exam preparation: 40 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Fundamentals of biogenic residues and biomass • Fundamentals of thermo-chemical conversion processes for solid input materials, in particular residual materials (focus: pyrolysis and gasification) • Production of 3rd generation fuels (from gasification and pyrolysis) • Process comparison to the status of technology of thermo-chemical conversion processes • Innovative conversion processes • Basics for the analysis of conversion products • Characterisation and evaluation of products from the conversion of biomass and residues • Application options for the products produced • Operation of thermo-chemical conversion plants • Safety-relevant aspects of conversion plants • Experimental design and evaluation • Parameter variation and development of targeted test series
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to

- the considered thermo-chemical conversion process for generation of generation fuels and the utilisation of the biogenic energy sources and residues produced (2).
- be able to apply the basic knowledge regarding the operation of process engineering systems and safety-relevant considerations in the application of conversion processes (2).
- apply their skills with regard to the operation of innovative conversion technologies for the production of new energy sources based on residual materials and biomass as well as the evaluation of test series and parameter variations in engineering work and projects (3).
- to be able to create basic test procedures for 3rd generation conversion processes (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, task description, task definition
Teaching media
Computer/beamer, blackboard/flipchart
Literature
• Hornung, A. Pyrolysis. In Transformation of Biomass: Theory to Practice, 1st ed.; Hornung, A., Eds; John Wiley & Sons, Ltd: Chichester, U.K., 2014; Chapter 4, pp 99112, DOI: 10.1002/9781118693643.ch4. • Kaltschmitt, Martin, Hartmann, Hans, Hofbauer, Hermann: Energy from Biomass, ISBN 978-3-540-85095-3, Springer Verlag, 2009 • Wim P. M. van Swaaij, Sascha R. A. Kersten, Wolfgang Palz: Biomass Power for the World, 2015, Pan Stanford, Pan Stanford Series on Renewable Energy, ISBN 9789814613880 • Schönbucher, Axel: Thermal Process Engineering - Fundamentals and Calculation Methods for Equipment and Processes, ISBN 978-3-540-42005-7, Springer Verlag, 2002
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Finite elements (EI, ISE, REE)		
Person responsible for the module	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Fundamentals of electrical engineering, technical mechanics

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Finite elements (EI, ISE, REE)	4 SWS	5

Submodule		**TM abbreviation**
Finite elements (EI, ISE, REE)		**FE**
Person responsible	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Robert Sattler	only in the summer semester	
Teaching form		
Lectures with practical training on the computer		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h; Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Mathematical basics of the finite element method • Setting up of the element equation system from energy principles resp. with variation approaches and different approach functions • Set up the overall equation system taking into account the boundary conditions • (Iterative) solution methods for (non-)linear systems of equations Practical procedure for creating FE models Geometry creation or import, material assignment, defining various boundary conditions, meshing control, extracting and visualising calculation results, using symmetries to reduce model size Calculation examples • Calculations in various physical domains (thermal, mechanical, electrical, magnetic, fluidic) and their coupling • Stationary and dynamic (modal and transient analysis) questions

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • describe the process of an FE simulation (1) • name the mathematical principles of the FEM (1) • perform simple calculations with an FE programme (2) • perform more complex calculations with an FE programme (3) • Interpret error messages from the programme (3) • Assess the results of the calculation (3) • for independent familiarisation with unknown functions of the FE programme using the English programme documentation (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, worksheets, bibliography, sample programmes
Teaching media
Blackboard, projector, computer
Literature
A first course in finite elements, B. Fish One-dimensional finite elements: An introduction to the method, M. Merkel The Finite Element Method: Basic Concepts and Applications with MATLAB, MAPLE, andCOMSOL, D. Pepper Finite Element Methods: A Practical Guide, J. Whiteley Finite Element Method, O.C. Zienkiewicz

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Finite Element ME (Finite Element Simulation)		17
Person responsible for the module	Faculty	
N.N.		

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Mandatory requirements
none
Recommended prior knowledge
Fundamentals of electrical engineering, technical mechanics

Assigned submodules:

No.	Designation of the sub-modules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Finite elements ME (Finite Element simulation)	4 SWS	5

Submodule		**TM abbreviation**
Finite Element ME (Finite Element Simulation)		**FE**
Responsible person	Faculty	
Teacher / Lecturer	Offer frequency	
N.N.	only in the summer semester	
Teaching form		
Lecture with practical course on the computer		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h; Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

Mathematical basics of the finite element method

- Setting up of the element equation system from energy principles resp. with variation approaches and different approach functions.
- Setting up the overall system of equations taking into account the boundary conditions (iterative) solution method for (non-)linear systems of equations

Practical procedure for the creation of FE models

- Geometry creation or import, material assignment
- Defining various boundary conditions
- Network control
- Extracting and visualising calculation results
- Use of symmetries to reduce the model size.

Calculation examples

- Calculations in various physical domains (thermal, mechanical, electrical, magnetic, fluidic) and their coupling
- Stationary and dynamic (modal and transient analysis) questions

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • describe the process of an FE simulation (1) • name the mathematical principles of the FEM (1) • perform simple calculations with an FE programme (2) • perform more complex calculations with an FE programme (3) • Interpret error messages from the programme (3) • Assess the results of the calculation (3) • for independent familiarisation with unknown functions of the FE programme using the English programme documentation (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, worksheets, bibliography, sample programmes
Teaching media
Blackboard, projector, computer
Literature
• A first course in finite elements, B. Fish • One-dimensional finite elements: An introduction to the method, M. Merkel • The Finite Element Method: Basic Concepts and Applications with MATLAB, MAPLE, and COMSOL, D. Pepper • Finite Element Methods: A Practical Guide, J. Whiteley • Finite element method, O.C. Zienkiewicz

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Semiconductor Circuit Technology (Solid State Circuit Design)	

Person responsible for the module	Faculty
Prof Dr Christian Schimpfle	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Mandatory requirements
None
Recommended prior knowledge
Contents of the lectures • Electronic components • Circuit technology

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Semiconductor circuit technology	4 SWS	5

Submodule	**TM abbreviation**
Semiconductor circuit technology	**HST**

Responsible person	Faculty
Prof Dr Christian Schimpfle	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Christian Schimpfle	only in the summer semester

Teaching form
Seminar-based teaching with 10-15 % exercises Supplementary offer: Research-based design analogue (REA)

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 56 h Exam preparation: 38 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Introduction, general principles • negative feedback, stability analysis • Current sources and current mirrors, voltage references • Basics of single-ended and differential amplifiers • Amplifier with negative feedback and active load • Large signal amplifier • Operational amplifier, Miller compensation • Linear and non-linear circuits with operational amplifiers • Basics of active filters • Realisation of active low, high and bandpasses • Filters with switched capacitances • Signal generators and oscillator circuits • Phase-locked loops and synthesis generators
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to

- to know and understand the design and circuit technology of operational amplifiers understand (1)
- know and understand general circuits with operational amplifiers (1)
- understand the basic function of active filters (1)
- know and understand how oscillators and phase-locked loops work (1)
- apply general analysis methods to calculate the properties of analogue circuits with semiconductor components (2)
- dimension integrable analogue circuits (2)
- Circuits for various analogue signal processing functions conceptualise and independently develop (3)
- build optimally suited integrated analogue circuits for switching and system applications (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Presentation slides, exercises, Spice simulation files, bibliography
Teaching media
Blackboard, projector
Literature
U. Tietze, C. Schenk: Semiconductor Circuit Technology, 13th edition, 2010 M. Seifart: Analogue circuits, 6th edition, 2003 L. v. Wangenheim: Analogue signal processing. Vieweg+ Teubner, 1st edition, 2010
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Hardware-Software-Codesign	

Person responsible for the module	Faculty
Prof Dr Florian Aschauer	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Mandatory requirements
Knowledge of the lecture "Digital Technology", knowledge of the lecture "Computer Science 1" and "Computer Science 2"
Recommended prior knowledge
Knowledge of the lecture "Digital Electronics" (Aschauer)

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Hardware-Software-Codesign	4 SWS	5

Submodule		**TM abbreviation**
Hardware-Software-Codesign		**HSC**
Responsible person	Faculty	
Prof Dr Florian Aschauer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Florian Aschauer	in each semester	
Teaching form		
Seminar-based teaching with approx. 50% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62h, Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Overview of FPGA and system-on-a-chip components • Structure - Introduction to the hardware description language VHDL • Concurrent and sequential language elements • Coding examples of the basic blocks - State machines • Design via state diagram • Design with hardware description languages - Systematic design of complex digital systems • Register planning • Timing planning with spreadsheet • Application example RS232 interface - familiarisation with the VIVADO development system (XILINX Inc.) - Development of hardware basis • AXI register interface • Basic design with AXI register interface, AD converter, SPI interface, DA converter • VHDL code, simulation models • Block design with Processing System (PS) • Configuration PS • Integration of hardware block in block design • Transfer to Software Development Kit VITIS - Bare metal design (without operating system) • Test, creation of simple C programmes (memory I/O) for communication with the hardware base - Operation with LINUX operating system • Creation of customised LINUX system with PETA-LINUX • Host PC/LINUX operating system communication via Ethernet, FTP, SSL • Creation of simple C programmes (memory I/O), start and test via Ethernet/LINUX

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Specify the structure of the All Programmable System-on-Chip (AP SoC) devices (1) • use the design software VIVADO and VITIS (2)

- overview of the toolchain (2)
- work with VHDL editor and simulator (2)
- Perform synthesis and hardware download (2)
- Perform the SDK export (2)
- realise bare metal applications (2)
- How to use the LINUX operating system (2)
- independently design complex embedded systems on an AP SoC basis (3)
- develop timing planning, RTL partitioning, VHDL coding (3)
- Interface design, interface programming design (3)
- dimension driver and application programming (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Cloze script, instructions for laboratory exercises, design examples, bibliography
Teaching media
Computer workstation with VIVADO and VITIS design software, XILINX-ZYNQ7020 development board, test benches, measuring devices
Literature
Navabi, Zainalabedin: "VHDL Analysis and Modelling of Digital Systems", McGraw Hill 1993 XILINX Inc: HighLevel Synthesis: UG871 (v2016.1) April 6, 2016 XILINX Inc: Vivado Design Suite User Guide: Synthesis: UG901 (v2016.1) April 1, 2015 XILINX Inc: UltraFast Design Methodology Guide for the Vivado Design SuiteXILINX Inc: Zynq-7000-Technical Reference Manual: ug585-Zynq-7000-TRM.pdf, 2017 L. H. Crockett, R. A. Elliot, M. A. Enderwitz and R. W. Stewart, The Zynq Book: Embedded Processing with the ARM Cortex-A9 on the Xilinx Zynq-7000 All Programmable SoC, First Edition, Strathclyde Academic Media, 2014.
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please compare the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Radio Frequency Engineering		
Person responsible for the module	Faculty	
Prof Dr Susanne Hipp	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
1st study section; fields, waves, lines

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	High frequency technology	4 SWS	5

Submodule	**TM abbreviation**
High frequency technology	**HFT**

Person responsible	Faculty
Prof Dr Susanne Hipp	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Susanne Hipp	only in the summer semester
Teaching form	
Seminar-based teaching, 10-15% exercises, practical experiments	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Electromagnetic wave propagation (frequency ranges, propagation)
- Waveguides and modes (theory/simulation)
- S-parameter and network analyser, also multi-gates
- Power measurement up to the highest frequencies
- Frequency measurement up to the highest frequencies
- Time domain measurements
- Effect of electromagnetic radiation on humans
- Resonators and filters
- Theory and simulation of extended antenna shapes and their applications

The students should learn the following skills for designing an antenna in a practical exercise:

- Design and layout
- Fabrication
- Measurement of the resonance and the antenna pattern

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • wave propagation boundary conditions with regard to frequency range (1) • List methods for measuring power and frequency as well as measurement methods in the time domain (1) • List waveguide types and resonators/filters (1) and design common cable types (2) • Specify properties of antennas (1) • assess the effect of radiation on humans (2) • calculate and simulate RF lines and antennas (3) • Measurements in thearea of high-frequency transmission technology to carry out, record (2) and assess (3) • High-frequency components, conductors and antenna on the basis of given task (2)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Slides, script, exercises, animations, bibliography, experiment instructions, scripts for the underlying lectures
Teaching media
Overhead projector, blackboard, computer/beamer, experimental set-ups
Literature
Detlefsen J., Siart U.: Fundamentals of high frequency technology, 4th edition. Oldenbourg (2012) and see fields, waves, lines
Further information on the course
If required, the course will be held in English. It is not guaranteed that the course can be offered in every semester according to the frequency. Please compare the curriculum table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
High voltage engineering with practical training (High Voltage Engineering with Lab Course)		HSP
Person responsible for the module	Faculty	
Prof Dr Franz Fuchs	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Fundamentals of electrical engineering; electrical systems engineering

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	High voltage technology	2 SWS	2.5
2.	Internship High Voltage Technology	2 SWS	2.5

Submodule		**TM abbreviation**
High voltage technology		**HS**
Person responsible	Faculty	
Prof Dr Franz Fuchs	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Franz Fuchs Prof Dr Matthias Haslbeck	only in the winter semester	
Teaching form		
Seminar-based teaching: 15-20% exercise component		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2.5

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 32 h Exam preparation: 15 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Fields of work in high-voltage technology • Electric fields and stresses (terms, field equations, degree of homogeneity, stresses) • Determination of electric fields (elementary fields, superposition of elementary fields, technical fields) • Electrical strength and insulating materials (statistical principles, breakdown process, service life)
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Know the terms and electrode arrangements of high-voltage technology (1) • the basic principles of high-voltage technology, an overview of field calculation methods, basic knowledge of breakdown processes and the electrical properties of gaseous, liquid and solid insulating materials (2) • understand and apply the analytical and approximate solution approaches for the calculation of electric fields and assess the high-voltage requirements (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Bibliography, presentation slides, exercises
Teaching media
Blackboard, computer/beamer
Literature
Küchler, A: High voltage engineering, Springer-Verlag, 2017 Kind, D., Kärner, H.: Hochspannungs-Isoliertechnik, Vieweg-Verlag, 1982 Beyer, M., Boeck, W., Möller, K., Zaengl, W.: Hochspannungstechnik , Springer-Verlag, Berlin, 1986
Further information on the course
• Supplementary offer: Practical course in high-voltage technology • It is not guaranteed that the course can be offered in every semester according to the frequency. Please compare the curriculum table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		**TM abbreviation**
Internship high voltage technology		**PHS**
Responsible person	Faculty	
Prof Dr Franz Fuchs	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Franz Fuchs Prof Dr Matthias Haslbeck	only in the winter semester	
Teaching form		
see curriculum		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2.5

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up of the experiments: 32 h, Preparation of performance record: 15 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Safety equipment in a high-voltage laboratory • Dissipation factor and capacitance measurement under high voltage • Surge voltage testing and measurement technology • Breakdown mechanisms in gases • Calculation of electrostatic fields using the finite element method
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • the safety equipment and the testing and -measuring equipment in in a high-voltage laboratory (1) • be able to analyse the breakdown processes of gases and their basic influencing parameters (2) • safely operate and use high-voltage test and measurement equipment for surge and alternating voltage (2) • Understand and apply non-destructive diagnostic methods, such as dissipation factor measurement (3) • understand and use an FEM programme for electrical field calculation (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Instructions for the individual experiments Additional information on the laboratory homepage
Teaching media
Test set-ups, electronic measurement protocols, programme for field calculation with FEM
Literature
D. Kind / K. Feser Introduction to high-voltage experimental technology. Vieweg-Verlag, Brunswick, 1995 Küchler, A: High voltage engineering, Springer-Verlag, 2017
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
IC technology (Integrated Circuit Technology)		
Person responsible for the module	Faculty	
Prof Dr Rainer Holmer	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	IC technology	2 SWS	3
2.	Internship IC Technology	2 SWS	2

Submodule		**TM abbreviation**
IC technology		**TI**
Person responsible	Faculty	
Prof Dr Rainer Holmer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Rainer Holmer	only in the summer semester	
Teaching form		
Seminar-based teaching with 10 - 15% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	3

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 46 h Exam preparation: 16 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
Methods and processes of semiconductor production: • Production of silicon wafers • Photolithography (and its physical limits) • Etching process • Thermal oxidation • CVD and PVD processes for coating deposition • Doping processes and diffusion processes • Overall process conceptsProcess control methods (SPC)
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Basic production processes for the manufacture of monolithic integrated semiconductor devices and microelectronic circuits (1) • Interpret important physical limits of modern semiconductor production (3) • Correctly estimate (orders of) magnitude of process parameters (3) • Interpret simple process sequences for the production of semiconductor structures (including their simulation if necessary) (3) • Design simple process sequences for the production of semiconductor structures (3) • assess process concepts (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, bibliography
Teaching media
Overhead projector, blackboard, computer/beamer
Literature
[1] U. Hilleringmann: Silicon Semiconductor Technology, 5th edition, Vieweg+Teubner, 2008 [2] G. Schumicki, P. Seegebrecht: Process Technology, Springer, 1991 [3] D. Widmann, H. Mader; H. Friedrich: Technologie hochintegrierter Schaltungen, 2nd ed. Springer, 1996 [4] S.M. Sze: VLSI Technology, McGraw-Hill, 2nd ed., 1988
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		**TM abbreviation**
Internship IC Technology		**PTI**
Person responsible	Faculty	
Prof Dr Rainer Holmer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Rainer Holmer	only in the summer semester	
Teaching form		
Project internship		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2

Time required:

On-campus study programme	Self-study
28 h	32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

Design, manufacture, measurement and evaluation of thick-film circuits (hybrid integration):

- Design of a thick-film circuit using a CAD tool in accordance with specified Circuit specifications
- Manufacture of three screens for guideway, resistance and solder printing
- Guideway pressure, resistance pressure, solder pressure
- Loading the substrates
- Reflow soldering
- Separating the substrates
- Electrical measurements on test structures and circuits
- Statistical analysis of the measurementsPresentation of the results

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- substrate and paste properties of thick film technology (2)
- Handle the process steps for manufacturing integrated circuits using thick-film technology (2)
- Apply necessary design rules (1)
- Interpret the influence of manufacturing conditions on circuit characteristics (3)

- Manage the statistical recording and description of production fluctuations (2)
- Carry out a layout design according to given circuit specifications in compliance with the design rules (2)
- Create a log of the production process effectively (2)
- A critical evaluation and commentary of measurements on thick-film circuits (2)
- Present technical facts and competences effectively (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Experimental instructions, textbook
Teaching media
Overhead projector, blackboard, computer/beamer
Literature
[1] H. Reichl: Hybridintegration, Hüthig-Verlag, 1988
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Communication Networks		
Person responsible for the module	Faculty	
Prof Dr Mathias Bischoff	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
1st study section

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Communication networks	4 SWS	5

Submodule	TM abbreviation
Communication networks	**CN**

Responsible person	Faculty
Prof Dr Mathias Bischoff	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Mathias Bischoff	only in the winter semester
Teaching form	
Seminar-based teaching: 10-15% exercise component	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 72 h Exam preparation: 22 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Structuring of networks • Functionality of network nodes • Multiple access procedure • Securing point-to-point connections • Grid connection • Signalling • Waiting room theory • End-to-end transport • Application services • Next Generation Networks
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Name network topologies and their properties (1) • Describe network elements and their internal structure (1) • describe common protocols including how they work (1) • calculate networks and systems on the basis of given boundary conditions (2) • analyse networks with the layer model (3) • recommend suitable protocols (3)

• assess the performance of given networks (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script
Teaching media
Overhead projector
Literature
Tanenbaum, Computer Networks. Pearson, 2012 Kurose and Ross: Computer Networking - A Top-Down Approach. Pearson 2016
Further information about the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Power Electronics		
Person responsible for the module	Faculty	
Prof Dr Manfred Bruckmann	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	7

Recommended prior knowledge
Fundamentals of electrical engineering, maths 1-3, electronic components

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Power electronics	4 SWS	5
2.	Internship Power Electronics	2 SWS	2

Submodule			TM abbreviation
Power electronics			**LE**
Responsible person	Faculty		
Prof Dr Manfred Bruckmann	Electrical engineering and information technology		
Teacher / Lecturer	Offer frequency		
Prof Dr Manfred Bruckmann	in each semester		
Teaching form			
Seminar-based teaching with 10-15 % exercises Supplementary practical course in power electronics			

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Basics of power electronic energy converters • Differences between line-commutated and self-commutated circuits • Self-guided Circuits: Introduction Classification and overview of DC/DC converters; single-quadrant / multi-quadrant converters • Pulse inverter single-phase / three-phase • Design of power electronic systems • Power electronics components and their areas of application • Simulation of power electronic circuits
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know, classify and evaluate the most important basic power electronic circuits for the realisation of rectifiers, DC converters, inverters and AC converters (1). (2) • know the most important power electronic components, their properties and areas of application. (1)

- Mains and load-side variables (current, voltage, power) of converter circuits to be determined and calculated. (2)
- apply Fourier analysis to network and load-side variables. (2)
- simulate simple converter circuits with the Spice simulation tool and interpret the values correctly. (3)
- Data sheets for assessment and selection optimally suitable components for power electronic circuits in a targeted manner. (2)
- Synthesis and dimensioning simple power electronic circuits independently. (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, Spice simulation files, bibliography
Teaching media
Blackboard, projector, computer
Literature
Specovious, J.: Basic course in power electronics: components, circuits and systems, Springer. Schröder, D.: Leistungselektronische Schaltungen. Springer. Schröder, D.: Leistungselektronische Bauelemente. Springer. Mohan, Undeland, Robbins: Power Electronics, Applications, Converters, and Design. John, Wiley & Sons.
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	TM abbreviation
Internship Power Electronics	**PLE**

Responsible person	Faculty
Prof Dr Manfred Bruckmann	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Manfred Bruckmann Prof Dr Christian Schimpfle	in each semester
Teaching form	
Laboratory internship	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2

Time required:

On-campus study programme	Self-study
28 h	32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Various experiments on power electronic circuits • Simulation of power electronic circuits • Application of theoretical principles for troubleshooting and analysing measurement data • Presentation and discussion of the measurement results in the form of characteristic curves • Comparison of the measurement results with the theoretical principles • Presentation technique, discussion skills
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know (1) and understand (2) the basic features of power electronic energy converters, • the characteristics of current power semiconductors to know (1) and evaluate their possible applications (2), • explain the structure of a circuit topology and its operating behaviour (1) and evaluate its use (2) • understand the various power electronic converters in terms of their range of application and operating limits (2)

• a from power electronic Actuators for one Application selection(3).	

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Descriptions of the individual experiments, manuals for the simulation software used
Teaching media
Power electronic test equipment, measuring devices, PC
Literature
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Machine Learning		
Person responsible for the module	Faculty	
Prof Dr Armin Sehr	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Machine Learning	4 SWS	5

Submodule		TM abbreviation
Machine Learning		**ML**
Responsible person	Faculty	
Prof Dr Armin Sehr	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Armin Sehr	in each semester	
Teaching form		
approx. 50% seminar-based teaching, approx. 50% practical training on the computer		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Supervised and unsupervised learning
- Regression, classification
- Linear regression, logistic regression
- Support Vector Machines and Kernel Methods
- K-means clustering
- Neural networks and deep learning
- Convolutional neural networks and image recognition

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- Name (1) and explain (2) terms such as features, classification, regression, supervised and unsupervised learning.
- name approaches such as linear regression, logistic regression, support vector machines, kernel methods, k-means clustering, neural networks, deep learning, convolutional neural networks (1), explain them (2) and use them to solve specific problems (3).
- methods for reducing the feature space dimension such as Principal Component Analysis and Linear Discriminant Analysis (3).

- a suitable optimisation method such as the steepest descent method, which stochastic gradient methods and optimisation with constraints to train models (3).
- learning method using a simulation language such as Matlab (3) (3).
- optimise the hyper-parameters of a learning procedure or model (3).
- recognise problems such as overfitting (2) and apply suitable countermeasures (3).
- assess which problems can be solved with machine learning (3).
- to abstract concrete problems (3) .
- develop solutions for pattern recognition problems (3).
- Identify improvement opportunities for pattern recognition problem solving (2) and implement (3).
- to select a suitable learning procedure for a given problem (3).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook). In addition, they are able to critically reflect on the use of ML algorithms in the context of technology assessment (2).

Training materials offered
Lecture slides, exercises, experiment instructions, sample programmes

Teaching media
Computer, projector, blackboard

Literature
G. James et al: An Introduction to Statistical Learning: with Applications in R, Springer 2011 I. Goodfellow et al: Deep Learning, MIT Press 2016 A. Geron: Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, O'Reilly 2019G. Strang: Linear Algebra and Learning from Data, Wellesley-Cambridge Press 2019

Further information about the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Measurement and Test Technology		
Person responsible for the module	Faculty	
Prof Dr Rainer Holmer	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Teaching content of the first study phase

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Measurement and test technology	2 SWS	3
2.	Measurement and test technology internship	2 SWS	2

Submodule		**TM abbreviation**
Measurement and test technology		**TT**
Responsible person	Faculty	
Prof Dr Rainer Holmer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Rainer Holmer	only in the summer semester	
Teaching form		
Seminar-based teaching with approx. 10 - 15% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	3

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 40 h Exam preparation: 22 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Basics of the Discrete Fourier Transform
- Window functions
- Application of the Discrete Fourier Transform to characterise AD and DA converters
- Static characterisation of analogue-digital converters
- Dynamic characterisation of analogue-digital converters in the frequency range
- Metrological determination of the parameters of AD converters
- Static characterisation of digital-to-analogue converters
- Dynamic characterisation of digital-to-analogue converters in time and frequency domain
- Test-friendly design of integrated digital circuits
- Testing integrated digital circuits with the test machine
- Error simulation
- Testing digital systems with Boundary Scan
- Static characterisation of operational amplifiers
- Dynamic characterisation of operational amplifiers
- Measuring the parameters of operational amplifiers

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Know and use measurement methods of AD and DA converters in detail (3) • apply test procedures and test-friendly design of integrated digital circuits in a targeted manner (2) • apply basic procedures for testing digital circuits in a targeted manner (2) • describe analogue measurement methods using the example of selected analogue circuits (1) • Solve measurement problems independently (3) • use state-of-the-art test hardware and software for testing integrated and discrete circuits in a targeted manner (3) • Describe the impact of the testing effort on time-to-market and costs (1) • Select (3), use (3) and evaluate (1) the cost of test hardware and software • Assess the interrelationship between test and design (2) • Precisely describe the positioning of the test in the complete production flow (2) • Use various microelectronics measurement methods in a targeted and competent manner (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises, bibliography
Teaching media
Blackboard, projector
Literature
Zerbst: Measuring and testing technology, Springer, 1986 Daehn, W.: Testverfahren in der Mikroelektronik Springer, 1997 Bennet, B.: Boundary Scan Tutorial, ASSET InterTech Inc., 2002
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	**TM abbreviation**
Measurement and test technology internship	**PTT**

Responsible person	Faculty
Prof Dr Rainer Holmer	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Rainer Holmer	only in the summer semester
Teaching form	
Laboratory internship	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2

Time required:

On-campus study programme	Self-study
28 h	32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Measuring the parameters of integrated analogue circuits: IEC bus measurement technology on Operational amplifier • Test programme creation and troubleshooting on a digital circuit: Using a test machine (in-house development) • Fault simulation and test programme validation for a digital circuit • Measuring the parameters of AD and DA converters: dynamic parameters, static parameters (simulation, in-house development) • Creation and testing of a boundary-scan test programme (VHDL-based simulation, in-house development)
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Describe test strategies for complex test objects (1) • explain computerised test procedures (1) • Use design-flow-relevant software tools for test preparation (2) • Strategies to use for test-friendly design (1) • use common test hardware and software testing integrated circuits (2) • interpret (3) and visualise (1) the results of series measurements • independently design test programs and test procedures for analogue, digital and mixed integrated circuits (3)

- practically implement the most important measurement and test procedures in microelectronics (2)
- correctly assess the problem of test costs (2)
- plan practical experiments in group work (3)
- Carry out experiments in group work (2)
- Interpret test results in a team (3)
- to develop a documentation together in a team (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Tasks, structure description, catalogues, bibliography
Teaching media
Experimental setups, computers, C-compilers, simulators
Literature
IRSIM Manual Zerbst: Measuring and testing technology, Springer, 1986 Daehn, W.: Testverfahren in der Mikroelektronik Springer, 1997 Bennet, B.: Boundary Scan Tutorial, ASSET InterTech Inc., 2002
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Network planning and grid control		
Person responsible for the module	Faculty	
Prof Dr Oliver Brückl	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Electrical power distribution or electrical grid technology

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Grid planning and grid control	4 SWS	5

Submodule		**TM abbreviation**
Grid planning and grid control		**NPR**
Person responsible	Faculty	
Prof Dr Oliver Brückl	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Oliver Brückl	only in the winter semester	
Teaching form		
Seminar-based teaching: 10-15 % exercise component		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Introduction to network planning • Creation of network models with simulation of network users • Principles and measures for voltage maintenance • Basics of frequency maintenance (network characteristics and simplified dynamics) • Reliability of supply • Network development plan • Voltage quality
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • be able to explain the main features of network planning (1) • El. networks to be able to model (2) • be able to explain challenges and solutions for the integration of new network users (3) • be able to describe frequency maintenance (1) and apply the network characteristic method (3) • to be able to specify descriptive parameters of supply reliability (1) • be able to describe the network development plan (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Slides, script incl. exercises
Teaching media
Blackboard, computer/beamer
Literature
IfE publication series booklet 23 - "Frequency active power and voltage reactive power control", E & M Verlag, Herrsching
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Optoelectronics, LED & Lasertechnology		
Person responsible for the module	Faculty	
Prof Dr Heiko Unold	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
1st study section, physics, components and electronics

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Optoelectronics, LED & Laser technology	4 SWS	5

Submodule		**TM abbreviation**
Optoelectronics, LED & Lasertechnology		**OLL**
Responsible person	Faculty	
Prof Dr Heiko Unold	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Heiko Unold	only in the winter semester	
Teaching form		
Seminar-based teaching with practical training (approx. 50%)		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Perception and description of light (photometric and radiation physics) sizes, colourimetry)
- Fundamentals of technical optics (ray optics, matrix optics, real lenses, aberrations)
- Basics of wave optics and applications (Fabry-Perot resonator, dielectric coatings, Gaussian beams, polarisation)
- Basic principle of optical detectors
- Semiconductor materials and structures for efficient generation of optical radiation (direct semiconductors, hetero-quantum structures, efficiencies)
- Design, operation and measurement technology of modern power LEDs
- Overview about Functional principle, designs, operating modes, characteristics and applications of different laser types

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- Use basic terms and dimensions of lighting technology and optoelectronics in a meaningful (1)
- Correctly answer at least 40% of a previously known selection of topics (see contents) and associated task types within the examination time (2)

- Work independently in a team on a self-chosen project (optoelectronic measurement technology, simulation, construction of simple demonstrators) and to present them in an understandable and competent manner (3)
- possibly relate and understand given texts from specialised literature to the lecture content (3, not tested)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Presentation slides, exercises, simulation files, literature (e-books)
Teaching media
Interactive ELO course, projector, blackboard, experiments, laboratory
Literature
Meschede: "Optik, Licht und Laser", Vieweg+Teubner Ver., 3rd ed. 2008 Schubert: "Light Emitting Diodes", Cambr. Univ. Press, 2nd edition 2006 Eichler: "Laser. Designs, beam guidance, applications", Springer Verlag, 8th edition 2015
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Photovoltaics and Solar Thermal (Photovoltaics and Solar Thermal Energy)		
Person responsible for the module	Faculty	
Prof Dr Michael Sterner	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Physics, Maths 1 and 2, Fundamentals of Electrical Engineering 1 and 2, Engineering Mechanics, Materials science

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Photovoltaics and solar thermal energy	4 SWS	5

Submodule		**TM abbreviation**
Photovoltaics and solar thermal energy		**PUS**
Person responsible	Faculty	
Prof Dr Michael Sterner	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Michael Sterner	only in the summer semester	
Teaching form		
Seminar-based teaching with approx. 10-20 % exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation; 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• The sun as an energy source - physical principles, radiation laws • Solar meteorology - types of radiation, influence of the atmosphere on solar radiation • Solar geometry - calculation of solar position and angle of incidence, types of irradiation on a horizontal and inclined plane, optimum alignment, tracking, shading • Measurement technology for solar radiation • Solar cells: Functional principle, photoelectric effect, structure, electrical properties, equivalent circuit diagrams, technologies, manufacturing processes, market shares • Solar generators: Structure, mode of operation, cabling, shading, components, inverters • Planning and design of grid-connected PV systems: Concepts, module selection, working areas, design of PV generator and inverter, design of lines, protection elements, cable plans, mounting, mounting systems and building integration, yield calculations • Planning and design of PV island systems: Hybrid systems, PV pumps, DC systems, solar home systems, charge controllers and batteries, yield calculations and system design • Economic efficiency and ecology of PV systems: investment calculations, life cycle assessments (CO2, environmental toxins), emissions (electrosmog, noise), recycling, energy amortisation • Solar collectors • Components of solar thermal systems • Solar thermal system technology • Solar thermal power plants
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know (1) and reproduce (1) the properties of solar radiation and its energy utilisation for photovoltaics, solar thermal power plants and systems • calculate solar variables such as angle of incidence, position of the sun and solar paths, shading (2) • understand the basics of photovoltaics, the functioning of PV cells and PV modules, the necessary components (2) and be able to explain them to non-experts (3) • be able to design grid-connected and stand-alone PV systems (3), including evaluation of possible applications on various buildings and open spaces • be able to calculate (2) and explain (3) important variables such as energy yield, economic efficiency and estimation of life cycle assessments • be able to explain the design and cost-effectiveness of PV and solar thermal systems to potential customers (3) and advise them on this (3) • understand the basics of solar thermal energy, the functioning of solar collectors, solar modules, solar systems and solar thermal power plants and the necessary components (2) and be able to explain them to non-experts (3) • be able to discuss solar energy in the context of the energy transition in a technically sound manner (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • organise and work in a team (2) • ask technical questions (3) and reproduce technical contexts in correct technical language (3)

- conduct critical discussions in an objective atmosphere (2)
- to deal constructively with different views and criticisms (3)
- appreciate the importance of careful, independent work for your learning success (3)
- Recognise the difference between understanding and simply applying solutions and take advantage of both approaches (3)
- to know the principles of good scientific practice (1) and
- be able to deal with scientific literature (2)

Training materials offered
Script, exercises with solutions, data sheets, videos, bibliography
Teaching media
Blackboard, computer/beamer, book chapter
Literature
• Quaschning, V.: Regenerative Energiesysteme, Hanser Verlag, Munich, 2013 • Häberlin, H.: Photovoltaics, AZ Verlag, Aarau, 2010 • Green, M.: Applied Photovoltaics, Earthscan Publications Ltd, 2009 • DGS: Guide to photovoltaic systems, DGS Berlin, (German Solar Energy Society), 2013
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Practical course in drive technology and power electronics (lab course) Electrical Drives and Power Electronics)		
Person responsible for the module	Faculty	
Prof Dr Manfred Bruckmann Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
For practical part drive technology: Lecture Electrical Machines and Lecture Drive Technology For practical part power electronics: Lecture power electronics

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Internship in drive technology and Power electronics	4 SWS	5

Submodule		**TM abbreviation**
Internship Drive Technology and Power Electronics		**PAL**
Responsible person	Faculty	
Prof Dr Manfred Bruckmann Prof Dr Bernhard Hopfensperger	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Manfred Bruckmann Prof Dr Bernhard Hopfensperger	in each semester	
Teaching form		
Laboratory practicals		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up of the experiments: 64 h, Exam preparation: 30 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Metrological Acquisition and Evaluation of properties drive technology Systems in stationary and dynamic operation • Operating behaviour and mode of operation of the speed adjustment of electrical machines • System analyses inverters and direct current machines as well as frequency converters and three-phase machines • Practical experiments on power electronic circuits • Simulation of power electronic circuits • Application of theoretical principles for troubleshooting and analysing measurement data • Presentation and discussion of the measurement results in the form of characteristic curves • Comparison of the measurement results with the theoretical principles • Presentation and discussion of the results
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Identify (2) and assess (3) potential hazards • plan (2) and carry out (3) measurements on drive systems • design (2) and construct (3) power electronic circuits with functional reliability

- determine (2), describe (2) and evaluate (3) measurement results - Create simulation models (2) and use them in a targeted manner (3)	
Learning objectives: Personal competence	
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).	
Training materials offered	
Tasks, script, bibliography, manuals of the simulation software	
Teaching media	
Machine sets, power converters, power electronic test equipment, measuring devices, simulation software, PC	
Literature	
Fischer, R.: Electrical machines, Hanser, 2013 Jäger, Stein: Exercises in power electronics, VDE Verlag, Berlin, 2012	
Further information on the course	
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.	

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Predictive maintenance		
Person responsible for the module	Faculty	
Prof Dr Markus Goldhacker	Mechanical engineering	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Knowledge of a programming language; you can familiarise yourself with Python in the first 2 weeks by means of tutorials recommended by the lecturer.

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Predictive maintenance	4 SWS	5

Submodule		**TM abbreviation**
Predictive maintenance		**PRM**
Responsible person	Faculty	
Prof Dr Markus Goldhacker	Mechanical engineering	
Teacher / Lecturer	Offer frequency	
Prof Dr Markus Goldhacker	only in the winter semester	
Teaching form		
Seminar-based teaching		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
See study plan table
Authorised aids for proof of performance
See study plan table

Contents
In this seminar, *machine learning* and *artificial intelligence* are discussed in the context of the machine construction in a practical way. Supervised and unsupervised learning algorithms are introduced in an application-oriented manner and are deepened and practised using examples, tasks and mini-projects in the context of predictive maintenance. In particular, the sub-aspects Remaining Useful Life (RUL) Prediction, Time to Failure (TTF) Prediction, Fault Classification, Anomaly Detection of Predictive Maintenance. As this is a current and dynamic topic, findings from current publications in the context of predictive maintenance are included in the seminar. **Concrete contents:** • What is Predictive Maintenance? Definition and Underlying Operationalisation: Remaining Useful, Life, Time to Failure • Introduction to machine learning: basic concepts, supervised and unsupervised learning, classification and regression, dimension reduction and finding patterns in data • In-depth study of selected supervised and unsupervised learning algorithms: e.g. support vector machines, random forest, clustering, PCA • Application of this understanding to the areas of RUL prediction, TTF prediction, fault classification, anomaly detection: how can machine faults be predicted? How can the health status of a machine be estimated using data? Reliability calculation of components • Evaluation of machine learning models: Confusion Matrix, Cross Validation • Deployment: Cloud and edge machine learning - how do you bring machine learning models into production? • The basic concept is the CRISP-DM cycle, with a focus on the areas of modelling, evaluation and deployment The working medium is the programming language *Python* and *JupyterLab/JupyterNotebook*. Students can familiarise themselves with *Python* in the first few weeks of the course by means of tutorials and further Python knowledge is taught *on-the-fly* in parallel with the content topics.
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • understand the underlying concepts and methods of predictive maintenance and apply them in everyday industrial practice. (2) • understand supervised and unsupervised learning methods generically and apply them specifically in the areas of RUL/TTF prediction, fault classification and anomaly detection. (2) • Precisely plan maintenance and servicing measures on a data-driven basis. (2) • to estimate the wear stock of a machine or its components on a comparative basis. (2) • assess the potential by replacing components at the optimum time. (2) • Use data from industrial plants to train machine learning models in a mechanical engineering context and evaluate them using e.g. confusion matrices and cross-validation. (2) • implement all the methods and concepts mentioned using the Python programming language. (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • to propose a sustainable utilisation of plant and machine components. (2) • assess the impact of machine learning methods in the industrial sector. (2) • independently implement projects in the field of machine learning in an industrial context and work seamlessly with software developers/data engineers. (2) • independently research current scientific literature and publications in the context of predictive maintenance and machine learning. (2)
Training materials offered
Slides and exercise sheets in the form of Jupyter notebooks
Teaching media
Overhead projector, blackboard
Literature
• VanderPlas, J. Python Data Science Handbook: Essential Tools for working with Data. O'Reilly UK Ltd. 2016. • Aurélien Géron. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition. O'Reilly Media, Inc. 2019. • Allen B. Downey. Think Stats: Exploratory Data Analysis. O'Reilly UK Ltd. 2014. • Christopher M. Bishop. Pattern Recognition and Machine Learning. Springer. 2006.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Control Engineering Applications (Applications of Control Engineering)		
Person responsible for the module	Faculty	
Prof Dr Claus Brüdigam	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Control engineering Microcomputer technology, practical course in microcomputer technology

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Control engineering applications	4 SWS	5

Submodule		**TM abbreviation**
Control engineering applications		**RTA**
Responsible person	Faculty	
Prof Dr Claus Brüdigam	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Claus Brüdigam	in each semester	
Teaching form		
Seminar-based teaching with practical work in the laboratory		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up, exam preparation: 90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Basic structure and function of analogue and digital control loops
- Modelling of mechatronic systems using the example of an automotive throttle valve
- Controller setting according to Ziegler/Nichols using the example of a temperature controlled system
- Controller design with the aid of root locus curves (continuous-time)
- Digital realisation of analogue control concepts
- Implementation of a control algorithm on a microcontroller
- Investigation of the stability and time behaviour as a function of the controller parameters and the pollages of the system
- Correspondences and calculation rules of the z-transformation
- Calculation of the system response in the time domain (z-back transformation)
- z-transfer function,
- Creation of a block diagram from the z-transfer function
- Causality, stability
- Controller design with the aid of root locus curves (discrete-time)
- Design of a discrete-time control algorithm
- Two- and three-point controller
- Testing, troubleshooting and optimisation of the designed controller
- Use of Matlab in the design of control loops
- Simulation of systems and control loops with Simulink
- Practical aspects in the realisation of digital control systems: pulse width modulation, quantisation, numerical problems, anti-wind-up, task scheduling

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- know the basic structure and function of analogue and digital control circuits (1)
- know the basic ideas of the discrete-time system description (1)
- know the z-transfer function and procedures for creating an algorithm (1)
- know how pulse width modulation works for power adjustment (1)
- be able to model and simulate complex systems and control loops (2)
- apply various procedures for controller design (3)
- use computer tools for the design and simulation of control loops (3)
- be able to create algorithms for the discrete-time realisation of a controller (2)
- suitable controllers for achieve the desired control targets select and dimensioning (2)
- be able to develop digital controls on microcontrollers / digital computers for real applications (2)
- be able to assess the control quality (2) and apply measures for optimisation (3)

Learning objectives: Personal competence

After successfully completing the sub-module, students are able to master at least 50% of the specialised content.
Personal skills are taught indirectly in the course, e.g. when formulating questions and concerns or completing laboratory appointments, which generally trains interaction with other people (e.g. fellow students and lecturers). Preparing for the exam teaches students to plan conscientiously and prepare thoroughly. However, these competences are not specifically tested.

Training materials offered	
Help sheets, exercises with sample solutions, experiment instructions, Matlab tutorial, bibliography	
Teaching media	
Blackboard, whiteboard, projector, PC workstation with Matlab/Simulink and µC development environment	
Literature	
• G. Schulz: Control engineering 2 (multivariable control, digital control engineering, fuzzy control) regulation). Oldenbourg Publishing House Munich • O. Föllinger: Linear scanning systems. Oldenbourg Publishing House, Munich • H. Unbehauen: Regelungstechnik II - Zustandsregelungen, digitale und nichtlineare Regelsysteme. Vieweg Verlag, Braunschweig • J. Lunze: Regelungstechnik 2 - Mehrgrößensysteme, Digitale Regelung: Springer Verlag, Berlin • E.-G. Feindt: Rules with the Computer, Sampling Controls with Special Consideration of Digital Controls. Oldenbourg Publishing House • Angermann, Beuschel, Rau, Wohlfarth: Matlab - Simulink - Stateflow. Oldenbourg Publishing House Munich	
Further information on the course	
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.	

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Circuit integration	

Person responsible for the module	Faculty
Prof Dr Christian Schimpfle	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Mandatory requirements
None
Recommended prior knowledge
Contents of the lecture Electronic Components

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Practical course in circuit integration	2 SWS	2
2.	Circuit integration	2 SWS	3

Submodule		TM abbreviation
Practical course in circuit integration		**PSI**
Responsible person	Faculty	
Prof Dr Christian Schimpfle	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Rainer Holmer Prof Dr Christian Schimpfle	only in the summer semester	
Teaching form		
Laboratory tests		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2

Time required:

On-campus study programme	Self-study
28 h	32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Circuit diagram and layout design of microelectronic function groups using CAE • Full custom design • Standard cell design - Verification of the circuit layout of the function groups • Design rule check, layout vs. schematic check • Investigation of the dynamic switching behaviour of CMOS gates by simulation • Investigation of metastability in digital circuits - Synthesis and analysis of a more complex CMOS function block - Measurements on semiconductor production discs (wafers) • Determination of the electrical properties of integrated transistors by measurement with parameter analyser • Determination of the SPICE parameters through alignment of the measurements with the descriptive equations (parameter fitting)

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know important CAE tools for the design and validation of integrated circuits (1) • apply geometric design rules (2) • operate the CAE tools provided for circuit diagram and layout generation and validation (2) • Extract circuit information from layouts and perform simulations based on this information (2) • Critically scrutinise and interpret validation and simulation results (3) • Create circuit diagrams and correct layouts independently (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • organise and divide tasks in a small group (3) • solve problems and correct errors within a given time frame within a group (3) • discuss and exchange expertise with other groups (3)
Training materials offered
Experimental instructions, script, bibliography
Teaching media
PC, beamer, blackboard, parameter analyser
Literature
N.H.E. Weste, K. Eshraghian: Principles of CMOS VLSI Design, Addison-Wesley, 2000 J. Lienig: Layout synthesis of electronic circuits, Springer, 2006 K. Hoffmann; System integration, Oldenbourg Verlag, 2011
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule	**TM abbreviation**
Circuit integration	**SI**

Person responsible	Faculty
Prof Dr Christian Schimpfle	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Rainer Holmer Prof Dr Christian Schimpfle	only in the summer semester

Teaching form
Seminar-based teaching, 10-15% exercises

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	3

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 46 h Exam preparation: 16 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Microelectronic systems
- Design types/styles
- Geometric design rules
- Switching behaviour of CMOS gates
- Integrated components
- Influences of the technology on the circuit design
- Computer-aided layout design

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to
- differentiate between full-custom design, cell-orientated design and array design and name advantages and disadvantages (1)
- know and understand the criteria for defining geometric design rules (1)
- understand the structure of CMOS gates in principle and be able to name their characteristic properties (1)
- Realisations of basic components (bipolar/field-effect transistors, passive components) in integrated circuits (1)
- assess the influence of technology on circuit design (1)
- Know layout data formats (CIF, GDFII, EDIF) (1)

- Various types of layout data management (linear lists, bins, tree structures) to know (1)
- Floor planning as well as placement and wiring methods (clustering, min-cut, maze routing, Lee algorithm, channel routing) (3)
- Know the basic principles of layout compacting (1)
- apply geometric design rules (2)
- familiarised placement and wiring algorithms to simple circuit examples (2)
- optimise the available chip area (3)
- create an optimised layout of CMOS gates (3)
- assess placement and wiring results (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, bibliography
Teaching media
Blackboard, projector
Literature
N.H.E. Weste, K. Eshraghian: Principles of CMOS VLSI Design, Addison-Wesley, 2000 J. Lienig: Layout synthesis of electronic circuits, Springer, 2006 K. Hoffmann; System integration, Oldenbourg Verlag, 2011
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Seminar in Technology and Management (Seminar in Technology, Entrepreneurship and Management)		
Person responsible for the module	Faculty	
Prof Dr Sean Patrick Saßmannshausen	Business and Management	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Seminar Technology, Entrepreneurship and management	4 SWS	5

Submodule		**TM abbreviation**
Seminar Technology, Entrepreneurship and Management		**TUM**
Responsible person	Faculty	
Prof Dr Sean Patrick Saßmannshausen	Business and Management	
Teacher / Lecturer	Offer frequency	
Prof Dr Sean Patrick Saßmannshausen Prof Dr Sevim Süzeroglu-Melchiors	only in the summer semester	
Teaching form		
Seminar-based teaching with case studies, preparation of a business case and business plan and presentation, group work, block courses		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
7	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Creation and testing of business cases • Lean Start-up Methodology • Business Model Canvas • Start-up process and start-up management • Positioning of new products • Market positioning • Entrepreneurial Marketing • Industrial structure analysis • Price planning • Capacity planning • Cost planning • Financial planning and sources of financing, including equity and venture capital • Basics of industrial property rights, patents, utility models and designs, • Copyrights • Property right searchesProperty right and exploitation strategies

Learning objectives: Professional competence
After successfully completing the sub-module, students will be able to The following qualification objectives are divided into different dimensions. Each dimension corresponds to a desired competence level. The following competence levels are categorised: Level 1 (Knowing): superficial understanding of simple structures or enquiry of acquired knowledge Level 2 (ability): superficial understanding of several structures through to a deeper understanding of relationships between structures or transferring, breaking down, combining and using what has been learnt Level 3 (Understanding and applying): deeper understanding of relationships between structures up to abstraction and extension to other structures or questioning and/or evaluating knowledge, explaining connections and effects. The dimension allocation of the qualification objectives is shown by the addition of the respective number (1, 2 or 3) in the competence description. On completion of the module, students will have achieved the following learning objectives based on scientific methods: <u>Expertise</u> Students are familiar with the importance and types of business models and the creation of business cases as well as the creation of business plans (1). They understand the role of company founders, successors and innovation managers in business planning process (2). They master the creation of business plans (3). The Students know the requirements of production planning, material flow planning and operational capacity planning for new products and companies with regard to capacity and personnel planning (1). <u>Social competence</u> Students understand how to drive forward the creation of business plans in results- and competition-orientated teams (3). They are able to work in teams in a goal-orientated manner (teamwork skills) and present the results and opinions they have developed in an appropriate and targeted manner (presentation skills) (3). They can present their point of view professionally (argumentation skills) (3). <u>Methodological expertise</u> Students master (3) methods of business planning, in particular the development of business models, they also understand (1) the requirements of creating business cases and plans. Students are familiar with the lean start-up methodology (1). <u>Personal expertise</u> Students are aware of the potential consequences of decisions in business cases and business plans and are able to incorporate these into their own business plans. value system (2). They have a self-efficacy conviction related to innovation and start-ups or succession (2), constructive problem-solving skills (2), a calculated willingness to take risks (2) and tolerance of ambiguity (1).

Learning objectives: Personal competence
After successfully completing the sub-module, students will be able to The following qualification objectives are divided into different dimensions. Each dimension corresponds to a desired competence level. The following competence levels are categorised: Level 1 (Knowing): superficial understanding of simple structures or enquiry of acquired knowledge Level 2 (ability): superficial understanding of several structures through to a deeper understanding of relationships between structures or transferring, breaking down, combining and using what has been learnt Level 3 (Understanding and applying): deeper understanding of relationships between structures up to abstraction and extension to other structures or questioning and/or evaluating knowledge, explaining connections and effects. The dimension allocation of the qualification objectives is shown by the addition of the respective number (1, 2 or 3) in the competence description. On completion of the module, students will have achieved the following learning objectives based on scientific methods: <u>Expertise</u> Students are familiar with the importance and types of business models and the creation of business cases as well as the creation of business plans (1). They understand the role of company founders, successors and innovation managers in business planning process (2). They master the creation of business plans (3). The Students know the requirements of production planning, material flow planning and operational capacity planning for new products and companies with regard to capacity and personnel planning (1). <u>Social competence</u> Students understand how to drive forward the creation of business plans in results- and competition-orientated teams (3). They are able to work in teams in a goal-orientated manner (teamwork skills) and present the results and opinions they have developed in an appropriate and targeted manner (presentation skills) (3). They can present their point of view professionally (argumentation skills) (3). <u>Methodological expertise</u> Students master (3) methods of business planning, in particular the development of business models, they also understand (1) the requirements of creating business cases and plans. Students are familiar with the lean start-up methodology (1). <u>Personal expertise</u> Students are aware of the potential consequences of decisions in business cases and business plans and are able to incorporate these into their own business plans. value system (2). They have a self-efficacy conviction related to innovation and start-ups and succession (2), constructive problem-solving skills (2), a calculated willingness to take risks (2) and tolerance of ambiguity (1).

Literature
<u>Mandatory literature</u> All case studies dealt with in the course (alternating, will be made available online via the e-learning platform GRIPS (Moodle)). Script for the event. Blank, Steve (2013): Why the Lean Start-Up Changes Everything. Harvard Business Review, Vol. 93(5), 64-72. Gilbert, C. G. / Eyring, M. J., (2010): "Beating the Odds when you Launch a New Venture." Harvard Business Review, Vol. 88(5), 92-98. Hisrich Robert D. Peters, M. P.; Shepherd, D. A. (2012): Entrepreneurship. Sage. Onyemah V.; Pesquera, M. R.; Ali, A. (2013): What Entrepreneurs Get Wrong, Harvard Business Review, Vol. 93(5), 74-79. Osterwalder, A., & Pigneur, Y. (2010). Business model generation: a handbook for visionaries, game changers, and challengers. John Wiley & Sons. Sahlman, W. A., "Some Thoughts on Business Plans." Research Note, Harvard Business School. Adams & Spinelli / Timmons, J. A., & Spinelli, S.: New venture creation: Entrepreneurship for the 21st century. <u>Additional recommended literature</u> Albers, Sönke & Gassmann, Oliver (eds.) (2005): Handbuch Technologie- und Innovationsmanagement: Strategie - Umsetzung - Controlling. Heidelberg et al: Springer (e- book). Allen, K.: Launching new Ventures - An Entrepreneurial Approach. Baron, R. A.: Entrepreneurship: An Evidence-based Guide. Baron, R. A., Shane, S. A.: Entrepreneurship: A Process Perspective. Disselkamp, Marcus (2012): Innovationsmanagement: Instrumente und Methoden zur Umsetzung im Unternehmen. Heidelberg et al: Springer (e-book). Malhotra, D. (2013): How to Negotiate with VCs Harvard Business Review, Vol. 93(5), 84-91. Mulcahy, D. (2013): Six Myths About Venture Capitalists. Harvard Business Review, Vol. 93(5), 80-83. Ries, Eric: The lean start-up. Roberts, M. J., Stevenson, H. H., Sahlman, W. A. et al: New Business Ventures and the Entrepreneur. Stern, Thomas & Jaberg, Helmut (eds.) (2007): Successful Innovation Management: Success Factors - Basic Patterns - Case Studies. Heidelberg et al: Springer (e-book). Volkmann, C., Tokarski, K., Grünhagen, M., Entrepreneurship in an European Perspective- Concepts and Growth of New Ventures. in the respective current edition

Further information on the course
The event is part of the joint focus on "Technology and Management". The course is offered jointly to students of business administration and electrical engineering and information technology.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Sensor principles (Fundamental Principles of Sensor Technology)	

Person responsible for the module	Faculty
Prof Dr Oliver Steffens	Applied natural and cultural sciences

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	4

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Sensor principles	4 SWS	5

Notes on compulsory occupancy or options
For a description of the Sensor Principles module, see the module handbook for the Bachelor's degree programme in **Environmental** and **Industrial Sensor Technology** (Faculty of Applied Natural and Cultural Sciences) on the homepage of the degree programme: https://www.oth-regensburg.de/ fakultaeten/angewandte-natur-und-kulturwissenschaften/studiengaenge/bachelor-umwelt-und- industriesensorik.html

Submodule		**TM abbreviation**
Sensor principles		**SP**
Responsible person	Faculty	
Prof Dr Oliver Steffens	Applied natural and cultural sciences	
Teacher / Lecturer	Offer frequency	
Prof Dr Oliver Steffens	only in the summer semester	
Teaching form		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Literature
Further information on the course
For a description of the Sensor Principles module, see the module handbook for the Bachelor's degree programme in **Environmental** and **Industrial Sensor Technology** (Faculty of Applied Natural and Cultural Sciences) on the homepage of the degree programme: https://www.oth-regensburg.de/ fakultaeten/angewandte-natur-und-kulturwissenschaften/studiengaenge/bachelor-umwelt-und- industriesensorik.html

Module name (English name if applicable)		Module code or no.
Simulation of electrical systems using Matlab, LTSpice and Julia		
Person responsible for the module	Faculty	
Prof Dr Susanne Hipp	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Contents
MATLAB Basics MATLAB gui, Graphics and 2D/3D Graphs Programming/functions in MATLAB Application of differential equations on circuits Transient and frequency domain simulations LTSpice introduction and basic models Julia Basics Graphs, functions and differential equations Circuits in Julia Parallelisation of calculations

Learning objectives: Professional competence
After successfully completing the module, students will be able to recall the basic functions of and in MATLAB, LTSpice and Julia (1) name the differences of the programmes (1) solve simple electrical systems and circuits using the programs (2) apply differential equations to circuits and find a solution (3) locate and apply new or unknown functions by searching the program help tools (2)

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Simulation of electrical systems using Matlab, LTSpice and Julia	4 SWS	5

Submodule		**TM abbreviation**
Simulation of electrical systems using Matlab, LTSpice and Julia		**MLJ**
Responsible person	Faculty	
Prof Dr Susanne Hipp	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Rainer Haller (LB) Prof Dr Susanne Hipp	only in the summer semester	
Teaching form		
Seminar-based teaching, practical course on the computer with 50% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German/English	5

Time required:

On-campus study programme	Self-study
56h	94h

Study and examination performance

Contents
MATLAB Basics MATLAB gui, Graphics and 2D/3D Graphs Programming/functions in MATLAB Application of differential equations on circuits Transient and frequency domain simulations LTSpice introduction and basic models Julia Basics Graphs, functions and differential equations Circuits in Julia Parallelisation of calculations
Learning objectives: Professional competence
After successfully completing the sub-module, students will be able to recall the basic functions of and in MATLAB, LTSpice and Julia (1) name the differences of the programmes (1) solve simple electrical systems and circuits using the programs (2) apply differential equations to circuits and find a solution (3) locate and appl
Training materials offered
Excercises, Sample programmes, GRIPS course

Teaching media
Board, beamer, computer
Literature
LTSpice: https://www.analog.com/en/analog-dialogue/articles/get-up-andrunning-with-ltspice.html MATLAB: https://de.mathworks.com/help/matlab/ Julia: https://docs.julialang.org/en/v1/

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
simulation techniques with matlab and simulink (Simulation techniques, Matlab - Simulink)		
Person responsible for the module	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Fundamentals of electrical engineering, computer science

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	simulation techniques with matlab and simulink (Simulation techniques, Matlab - Simulink)	4 SWS	5

Submodule		**TM abbreviation**
simulation techniques with matlab and simulink (Simulation techniques, Matlab - Simulink)		**SIM**
Responsible person	Faculty	
Prof Dr Robert Sattler	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Robert Sattler	only in the summer semester	
Teaching form		
Seminar-based teaching, practical course on the computer with 50% exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German/English	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Introduction to Matlab/Simulink - Import and export of data in different formats - Data processing - Symbolic and analytical calculations - Integration, differentiation - Optimisation and statistical methods - Data fit (Fourier analysis, regression) - Interpolation of data - Solution of equations and systems of equations - Solving differential equations and systems of equations - Data visualisation (2D, 3D and animation) - Programming of individual functions - Programme flow control - Use of various data formats - Application to engineering problems

Learning objectives: Professional competence
After successful completion of this submodule, students will be able to After successful completion of this submodule, students will be able to, - name the most important commands and routines of Matlab-Simulink (1) - solve simple engineering problems using Matlab/Simulink (2) - solve complex engineering problems using Matlab/Simulink (3) - Independently familiarise themselves with unknown functions of Matlab/Simulink (2-3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Exercises, worksheets, bibliography, sample programmes
Teaching media
Projector, computer
Literature
Pietruszka, Matlab and Simulink in Engineering Practice, Springer-Vieweg-Verlag Beucher, Matlab und Simulink - eine kursorientierte Einführung, mitp-Verlag Stein, Einstieg in das Programmieren mit Matlab, Hanser-Verlag Chapra, Applied Numerical Methods with Matlab for engineers and scientists, McGraw-Hill Hagl, Informatik für Ingenieure, Hanser Verlag
Further information about the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Simulation Management for Engineers (m/f/d) **(Simulation Business Management for Engineers)**	

Person responsible for the module	Faculty
Prof Dr Sean Patrick Saßmannshausen	Business and Management

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
The course is explicitly aimed at engineering students, including and especially if they have not yet acquired any knowledge of business administration. Previous knowledge is therefore not required for this course.

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Simulation business management for Engineers (m/f/d)	4 SWS	5
2.	Simulation business management for Engineers (m/f/d)	4 SWS	5

Submodule		TM abbreviation
Simulation Management for Engineers (m/f/d)		**UFI**
Person responsible	Faculty	
Prof Dr Sean Patrick Saßmannshausen	Business and Management	
Teacher / Lecturer	Offer frequency	
Prof Dr Sean Patrick Saßmannshausen Prof Dr Helmut Wittenzellner (LB)	only in the winter semester	
Teaching form		
Seminar-based teaching with approx. 80% exercises in the form of a business plan preparation and a business game simulation		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	94 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
The course teaches the basics of corporate planning and KPI-based planning. Analysing and deciding on company management. Based on the decisions of the seminar participants, company simulations are carried out in order to convey the material in an application-oriented manner. The course covers the following topics in detail: • Business planning for start-ups and new products • Creation of business plans and business cases • Key figure-orientated corporate management • Business analyses and key figure systems • Fundamentals of internal and external accounting • Terms and structures of cost and activity accounting • Basic business management terms and accounting variables, their interrelationships and their significance for operational management • Cost centres, cost units and cost element accounting • Contribution margin accounting and its significance operational management and economic success • Assignment-orientated cost and activity accounting and KPI-based corporate management in multi-product companies • Key figure-based corporate management in a computer-aided simulation
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Students understand how to create both the qualitative and the commercial-quantitative part of a business plan for business start-ups or for the market launch of new products of existing companies (business cases) (3). • Students will be able to familiarise themselves with and understand business accounting, accrual-based business analysis, commercial cost and performance accounting and KPI-based decision-making for corporate management (2). • Students can read and understand annual financial statements consisting of the income statement and balance sheet (1). • Students know the basics of corporate financing, the structure of equity and debt capital and the practical relevance of mezzanine capital positions, as well as the reasons for insolvency (1). • They are proficient in the key specialist terminology and can contextualise and interpret the terms; they are aware of the significance and interrelationships between business management parameters (2). • They will be able to discuss business topics and challenges with management in later professional situations using established terminology, develop solutions independently and demonstrate connections (2).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • The students train their ability to work in teams (the company simulation is carried out in fixed teams).

- The students learn methods for normative, strategic and operational
  They know how to define objectives in companies and can apply these in company negotiation situations.
- The students train their personal powers of persuasion in simulated loan negotiations and by giving a pitch or a business plan presentation as well as an annual financial statement presentation.

Training materials offered
• Computer-aided business simulation game. • Supplementary manuals and exercise materials as well as business game scenarios. • Sample templates
Teaching media
Computer-aided simulation game (can also be carried out online) and its output such as BWAs, internal and external accounting products, etc., blackboard, whiteboard, projector, instructional videos, role-play simulations, presentations, group work. All teaching media, including the business game, can also be used online via Zoom if necessary.

Literature
Compulsory literature: • The respective manual for the company simulation (provided as PDF). • Janes, G. (2017): Kostenrechnung: For study and practice. Stuttgart: W. Kohlhammer Verlag (is available as an e-book via VPN at the university library and can be used as a reference book during the course, it does not have to be read in its entirety). • Tanski, J. (2017): Annual financial statements: Bilanzen nach Handels- und Steuerrecht. 4th revised edition, Freiburg et al: Haufe-Lexware Verlag (is available as an e-book via VPN at the university library and can be used as a reference book during the course, it does not have to be read in its entirety). *Supplementary literature (for voluntary in-depth study and reference):* Essays: • Gottfredson, M., Schaubert, S. & Saenz, H. (2008): The New Leader's Guide to Diagnosing the Business: How can an incoming leader lay the groundwork for dramatic performance improvement? In: Harvard Business Review, No. 2/2008, pp. 63-73, as well as the related letters to the editor in the issue HBR No. 7/2008, pp. 152-153. Books (at least in the edition specified in each case or in a more recent edition): • Faltin, G. (2018): Head beats capital: The completely different way to start a business. Or: The desire to be an entrepreneur. 2nd ed. of the updated new edition from 2017, Munich: Deutscher Taschenbuch Verlag dtv. • Fueglistaller, U. et al (2019): Entrepreneurship. 5th revised edition, Wiesbaden: Springer Gabler. • Hahn, Christopher (2018): Financing start-up companies. Practical book for successful founders. Wiesbaden: Springer Gabler. • Heesen, B. (2019): Basiswissen Bilanzanalyse: Schnellller Einstieg in Jahresabschluss, Bilanz und P&L. 3rd edition, Wiesbaden, Springer Gabler. • Hisrich, R. D., Peters, M. P. & Shepherd, D. A. (2020): Entrepreneurship. 11th International Student Edition, New York: McGraw Hill. • Koss, C. (2006): Basiswissen Finanzierung: Eine Praxisnahe Einführung. Wiesbaden: Verlag Gabler. • Nickenig, K. (2019): The annual financial statements - a practice-oriented introduction. 3rd edition, Wiesbaden: Springer Gabler. • Volkmann, C. Tokarski, K. & Grünhagen, M. (2010): Entrepreneurship in a European Perspective. Wiesbaden: Verlag Gabler. Most of the above-mentioned books are available online as e-books via the OTH Regensburg University Library.

Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester. The event is part of the joint focus on technology and management.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		**TM abbreviation**
Simulation Management for Engineers (m/f/d)		**UFI**
Person responsible	Faculty	
Prof Dr Sean Patrick Saßmannshausen	Business and Management	
Teacher / Lecturer	Offer frequency	
Prof Dr Sean Patrick Saßmannshausen Prof Dr Helmut Wittenzellner (LB)	only in the winter semester	
Teaching form		
Seminar-based teaching with approx. 80% exercises in the form of a business plan preparation and a business game simulation		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	94 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
The course teaches the basics of corporate planning and KPI-based planning. Analysing and deciding on corporate management. Based on the decisions of the seminar participants, company simulations are carried out in order to convey the material in an application-oriented manner. The course covers the following topics in detail: • Business planning for start-ups and new products • Creation of business plans and business cases • Key figure-orientated corporate management • Business analyses and key figure systems • Fundamentals of internal and external accounting • Terms and structures of cost and activity accounting • Basic business management terms and accounting variables, their interrelationships and their significance for operational management • Cost centres, cost units and cost element accounting • Contribution margin accounting and its significance operational management and economic success • Assignment-orientated cost and activity accounting and KPI-based corporate management in multi-product companies • Key figure-based corporate management in a computer-aided simulation
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Students understand how to create both the qualitative and the commercial-quantitative part of a business plan for business start-ups or for the market launch of new products of existing companies (business cases) (3). • Students will be able to familiarise themselves with and understand business accounting, accrual-based business analysis, commercial cost and performance accounting and KPI-based decision-making for corporate management (2). • Students can read and understand annual financial statements consisting of the income statement and balance sheet (1). • Students know the basics of corporate financing, the structure of equity and debt capital and the practical relevance of mezzanine capital positions, as well as the reasons for insolvency (1). • They are proficient in the key specialist terminology and can contextualise and interpret the terms; they are aware of the significance and interrelationships between business management parameters (2). • They will be able to discuss business topics and challenges with management in later professional situations using established terminology, develop solutions independently and demonstrate interrelationships (2).
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • The students train their ability to work in teams (the company simulation is carried out in fixed teams).

- The students learn methods for normative, strategic and operational
  They know how to define objectives in companies and can apply them in company negotiation situations.
- The students train their personal powers of persuasion in simulated loan negotiations and by giving a pitch or a business plan presentation as well as an annual financial statement presentation.

Training materials offered
• Computer-aided business simulation game. • Supplementary manuals and exercise materials as well as business game scenarios. • Sample templates
Teaching media
Computer-aided simulation game (can also be carried out online) and its output such as BWAs, internal and external accounting products, etc., blackboard, whiteboard, projector, instructional videos, role-play simulations, presentations, group work. All teaching media, including the business game, can also be used online via Zoom if necessary.

Literature

Compulsory literature:

- The respective manual for the company simulation (provided as a PDF).
- Janes, G. (2017): Kostenrechnung: For study and practice. Stuttgart: W. Kohlhammer Verlag (is available as an e-book via VPN at the university library and can be used as a reference book during the course, it does not have to be read in its entirety).
- Tanski, J. (2017): Annual financial statements: Bilanzen nach Handels- und Steuerrecht. 4th revised edition, Freiburg et al: Haufe-Lexware Verlag (is available as an e-book via VPN at the university library and can be used as a reference book during the course, it does not have to be read in its entirety).

Supplementary literature (for voluntary in-depth study and reference):

Essays:

- Gottfredson, M., Schaubert, S. & Saenz, H. (2008): The New Leader's Guide to Diagnosing the Business: How can an incoming leader lay the groundwork for dramatic performance improvement? In: Harvard Business Review, No. 2/2008, pp. 63-73, as well as the corresponding letters to the editor in the issue HBR No. 7/2008, pp. 152-153.

Books (at least in the edition specified in each case or in a more recent edition):

- Faltin, G. (2018): Head beats capital: The completely different way to start a business. Or: The desire to be an entrepreneur. 2nd ed. of the updated new edition from 2017, Munich: Deutscher Taschenbuch Verlag dtv.
- Fueglistaller, U. et al (2019): Entrepreneurship. 5th revised edition, Wiesbaden: Springer Gabler.
- Hahn, Christopher (2018): Financing start-up companies. Practical book for successful founders. Wiesbaden: Springer Gabler.
- Heesen, B. (2019): Basiswissen Bilanzanalyse: Schnellller Einstieg in Jahresabschluss, Bilanz und P&L. 3rd edition, Wiesbaden, Springer Gabler.
- Hisrich, R. D., Peters, M. P. & Shepherd, D. A. (2020): Entrepreneurship. 11th International Student Edition, New York: McGraw Hill.
- Koss, C. (2006): Basiswissen Finanzierung: Eine Praxisnahe Einführung. Wiesbaden: Verlag Gabler.
- Nickenig, K. (2019): The annual financial statements - a practice-oriented introduction. 3rd edition, Wiesbaden: Springer Gabler.
- Volkmann, C. Tokarski, K. & Grünhagen, M. (2010): Entrepreneurship in a European Perspective. Wiesbaden: Verlag Gabler.

Most of the above-mentioned books are available online as e-books via the OTH Regensburg University Library.

Further information about the course

It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The event is part of the joint focus on technology and management.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Software-Defined Radio		
Person responsible for the module	Faculty	
Prof Dr Peter Kuczynski	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
1st study section

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Software-Defined Radio	4 SWS	5

Submodule	**TM abbreviation**
Software-Defined Radio	**SDR**

Person responsible	Faculty
Prof Dr Peter Kuczynski	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Peter Kuczynski	only in the winter semester
Teaching form	
Seminar-based teaching, 10-40% exercises, practical experiments	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Mobile radio systems, basic principles of mobile communication
- Access methods in mobile communication systems: TDMA, FDMA, CDMA, SDMA
- cellular concepts, sectorisation
- Bandpass system and equivalent low-pass system
- Transformation of bandpass signals into equivalent lowpass signals (theory and realisation concepts)
- Mobile radio channel (practical aspects, theory, modelling and simulation)
- Diversity concepts, frequency hopping
- Energy signals and power signals
- Correlation, power density spectrum, energy density spectrum
- Signal-matched filter (matched filter): Theory and application
- Binary signal transmission using the matched filter, first Nyquist criterion
- Basics of digital modulation (transmitter, receiver),
- Selected digital modulation methods e.g. PSK, QAM, MSK, GMSK
- Spread spectrum transmission, process gain, application of orthogonal signals (Walsh functions, OFDM)
- Interleaving, channel estimation using a pilot signal, synchronisation
- SDR methods in selected applicationse.g. in mobile radio systems
- Practical exercises using MATLAB, Simulink and an SDR system

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • evaluate selected transmission methods of digital mobile radio standards (2) • model mobile radio transmission and understand cellular concepts (3) • know the definitions of correlation functions, power density spectra and energy density spectra and apply them to different signal shapes (3) • theoretically understand the basic procedures for transforming bandpass signals into the baseband for the realisation of transmitters and receivers and practically implement them using software (3) • understand the theoretical principles of binary signal transmission using the signal-matching filter and realise them using software (3) • understand and evaluate the use of orthogonal signals for signal transmission in modern radio communication systems (3) • realise selected digital modulation methods with the aid of software (2) • interpret and evaluate the advantages of spread spectrum transfer (3) • interpret and evaluate diversity methods to improve transmission quality (3) • understand selected digital radio transmission methods and simulate and realise them using MATLAB and Simulink (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Scripts, exercises, bibliography
Teaching media
Overhead projector, blackboard, computer/beamer, MATLAB and Simulink simulation software
Literature
K.D. Kammeyer: Nachrichtenübertragung, 2nd and 4th edition, Teubner 1999 and 2008
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Software engineering in a team		
Person responsible for the module	Faculty	
Prof Dr Jürgen Mottok	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Programming in C and C++ (Computer Science 1 and 2, Practical Computer Science 1 and 2)

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Software engineering in a team	4 SWS	5

Submodule		TM abbreviation
Software engineering in a team		**SET**
Person responsible	Faculty	
Prof Dr Jürgen Mottok	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Jürgen Mottok	in each semester	
Teaching form		
Block course for the realisation of a software engineering project		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up, exam preparation: 90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Process models and phases of software development • Waterfall model • V-model • W model • Incremental models • eXTREME Programming • SCRUM - Phases of software development • Requirements Engineering • Analysis • Design • Implementation • Module test • Integration test • System test • Acceptance test • Maintenance - Fundamentals of functional safety - Basics of information security - Modelling techniques in the UML • Static (class diagram, ...) • Dynamic (sequence, activity, collaboration and status diagrams, ...) - Methodologies of software testing and software quality assurance - Review techniques - Advanced, object-orientated programming techniques - Databases - Design Pattern - Description of the task of the software project to be carried out

Learning objectives: Professional competence
After successfully completing the sub-module, students will be able to demonstrate the following competences according to Erpenbeck's competence grid: **Knowledge (1)** Knowledge of classic and agile process models of software development Knowledge of the content, methods and tools of the individual phases in the software lifecycle Knowledge of important document templates in the software development process **Skills (2)** Select and implement a process model in a team Elicit and manage requirements Create and manage software design using UML

Incorporate into an API and use it
Create implementation in C/C++, Java or Python (depending on the project) Use
software testing techniques
Collaborate in a team Manage conflicts
Carry out project organisation Manage
software

Expertise

The discussion of competences follows Erpenbeck's competence grid (Erpenbeck, 2017).

Expertise and methodological skills

- Independently apply a software development process (3)
- Independent recording of requirements (3)
- Independent UML modelling (3)
- Robust and correct implementation in C/C++ (3)
- Creative development of software test cases and test execution (3)
- Mastery of review techniques (3)
- Preparing together as a team (3)
- Documentation (specifications with UML diagrams) (3)
- Presentation of results, discussion of controversial solutions (3)
- Written and oral fluency in software engineering (2)
- Develop analytical skills and conceptual strength (3)
- Show judgement (3)
- Project management and planning behaviour (3)
- Proof of specialised knowledge acquired during studies (3)
- Ability to work systematically and methodically correct on a limited topic (systematic-methodical approach) (3)
- Proof of independence in solving a given task (originality of solution ideas) (3)
- Ability to problematise and (self-)criticise (systematic evaluation solutions) (3)
- Ability to argue logically and concisely (e.g. scientific writing) (3)
- Formally correct presentation of results (3)

Learning objectives: Personal competence

After successfully completing the sub-module, students will be able to demonstrate the following competences according to Erpenbeck's competence grid:

Personal competences
- Development of a normative-ethical attitude with regard to the social Technological impact of own scientific contribution (3)
- Show willingness to help in a team-orientated work process (3)
- Verify and discuss openness to changing boundary conditions and new findings from other members (3)
- Organising your own work process in self-management (3)
- Contributing ideas in a group with commitment (3)

Activity and action competence

- Develop the ability to make decisions when faced with several alternatives (3)
- Showing drive and creative will (3)
- Embracing different new ideas with an innovative spirit (3)
- Goal-orientated leadership in subtasks in smaller teams (3)
- Assuming and taking responsibility for a role in the team (3)
- Developing code as a software developer (3)
- Elicit and manage requirements as a requirements manager/product owner (3)
- Organising and managing the team as project leader/scrum master (3)
- Plan and manage status reports as a project manager (3)
- Creating software designs as an architect (3)
- Develop results-orientated action (3)
- Show perseverance in difficult situations (3)
- Adopt an optimistic attitude in project-orientated work (3)

Social and communicative competences

- Demonstrate conflict resolution skills (3)
- Show the ability to integrate and allow different positions in project-orientated work (3)
- Further develop your own teamwork skills (3)
- Develop your own problem-solving skills (3)
- Showing a willingness to understand in dialogue (3)
- Allow and try out new ideas with the joy of experimentation (3)
- Improve your own fluency in project-orientated work (3)
- Develop relationship management with stakeholders in the development process (3)
- Show a sense of duty in the project tasks (3)

Training materials offered
Tasks, auxiliary programmes for graphic output
Teaching media
PCs in the CIP pool, development environments, blackboard, projector
Literature
I, Sommerville, Software Engineering, Addison Wesley, 2009 H. Balzert, Software Technology, Volumes 1 and 2, Spektrum, 1996 R. Isernhagen, Software-Technik in C und C++, Hanser, 2004 http://de.selfhtml.org/ S.R.G. Fraser, Visual C++/CLI, Apress, 2006
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Software Engineering of Secure Systems (Software Engineering of Safe and Secure Systems)	

Person responsible for the module	Faculty
Prof Dr Jürgen Mottok	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Programming in C and C++ (IN1, PIN1, IN2, PIN2)

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Software engineering more secure Systems	4 SWS	5

Submodule	**TM abbreviation**
Software engineering of secure systems	**SES**

Person responsible	Faculty
Prof Dr Jürgen Mottok	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Jürgen Mottok	in each semester

Teaching form
Seminar-based form of teaching Online learning diary and learning portfolio Practical exercises approx. 50%

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up, exam preparation: 90 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
- Process models and phases of software development • Waterfall model • V-model • W model • Incremental models • eXTREME Programming • SCRUM - Phases of software development • Requirements Engineering • Analysis • Design • Implementation • Module test • Integration test • System test • Acceptance test • Maintenance - Fundamentals of functional safety - Basics of information security - Modelling techniques in the UML • Static (class diagram, ...) • Dynamic (sequence, activity, collaboration and status diagrams, ...) - Design Pattern - Methodologies of software testing and software quality assurance - Safe and Secure Coding Guideline - Review techniques - Advanced, object-orientated programming techniques - Databases - Design Pattern - Description of the task of the software project to be carried out
Learning objectives: Professional competence
After successfully completing the sub-module, students will be able to demonstrate the following competences according to Erpenbeck's competence grid: **Knowledge (1)** Knowledge of software development process models Knowledge of different phase models of software development Knowledge of important document templates in the software development process Knowledge of functional safety and IT security **Skills (2)** Use patterns in the various phases of software development Ability to compare patterns with regard to non-functional requirements Formulate requirements

Perform software design in UML
Correct implementation in C/C++ Using software
testing techniques

Expertise

The discussion of competences follows Erpenbeck's competence grid (Erpenbeck 2017).

Expertise and methodological skills

- Independently apply a software development process (3)
- Independent recording of requirements (3)
- Independent UML modelling (3)
- Independently identify design patterns for problem solutions (3)
- Robust and correct implementation in C/C++ (3)
- Creative development of software test cases and test execution (3)
- Independent modelling of an FMEA and FTA (2)
- Apply Safety Design Pattern (2)
- Apply security design pattern (2)
- Apply Safe and Secure Coding Guideline (3)
- Mastery of review techniques (3)
- Joint preparation in the team, commenting on the programmes (3)
- Documentation (specifications with UML diagrams) (3)
- Presentation of results, discussion of controversial solutions (3)
- Written and oral fluency in software engineering (2)
- Develop analytical skills and conceptual strength (3)
- Show judgement (3)
- Project management and planning behaviour (3)
- Proof of specialised knowledge acquired during studies (3)
- Ability to work systematically and methodically correct on a limited topic (systematic-methodical approach) (3)
- Proof of independence in solving a given task (originality of solution ideas) (3)
- Ability to problematise and (self-)criticise (systematic evaluation solutions) (3)
- Quality of the results - novelty, quality, reliability (3)
- Ability to argue logically and concisely (e.g. scientific writing) (3)
- Formally correct presentation of results (3)

Learning objectives: Personal competence

After successfully completing the sub-module, students will be able to demonstrate the following competences according to Erpenbeck's competence grid:

Personal competences

- Development of a normative-ethical attitude (3)
- Show willingness to help in a team-orientated working environment (3)
- Reliability in your own team (3)
- Openness to changing boundary conditions (3)
- Organising your own work in self-management (3)

- Contributing ideas to the team with commitment (3)

Activity and action competence

- Develop the ability to make decisions when faced with several alternatives (3)
- Demonstrate drive and creative will in research design (3)
- Embracing different new ideas with an innovative spirit (3)
- Goal-orientated leadership in subtasks in a team (3)
- Develop results-orientated action (3)
- Show perseverance in difficult situations (3)
- Giving impulses in team workshops (3)
- Acquiring optimistic attitudes in the team (3)

Social and communicative competences

- Demonstrate conflict resolution skills (3)
- Demonstrate the ability to integrate and allow different positions when working on tasks (3)
- Further develop your own teamwork skills (3)
- Develop your own problem-solving skills (3)
- Showing a willingness to understand in dialogue (3)
- Allow and try out new ideas with the joy of experimentation (3)
- Maturing your own fluency in a team (3)
- Develop relationship management in the team (3)Show a sense of duty in the tasks (3)

Training materials offered
• Script, set of slides, further sources in Moodle • Methodological approach inverted classroom, OLTB, portfolio
Teaching media
Projector, blackboard, moodle, classroom response system, online learning diary
Literature
I, Sommerville, Software Engineering, Addison Wesley, 2009 H. Balzert, Software Technology, Volumes 1 and 2, Spektrum, 1996 R. Isernhagen, Software-Technik in C und C++, Hanser, 2004 http://de.selfhtml.org/ S.R.G. Fraser, Visual C++/CLI, Apress, 2006 C. Eckert, IT-Sicherheit: Konzepte - Verfahren - Protokolle, De Gruyter, 2018.J. Börcsök, Funktionale Sicherheit: Grundzüge sicherheitstechnischer Systeme, VDE Verlag, 2014.
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Programmable controllers and practical training Automation technology (Programmable Logic Controller)	

Person responsible for the module	Faculty
Prof Dr Franz Graf	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Microcomputer technology, practical course Microcomputer technology, digital technology, practical course Programmable logic

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Internship automation systems	2 SWS	2
2.	Programmable logic controller Controls	2 SWS	3

Submodule		**TM abbreviation**
Internship automation systems		**PAS**
Responsible person	Faculty	
Prof Dr Franz Graf	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Franz Graf	in each semester	
Teaching form		
Laboratory internship		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	2

Time required:

On-campus study programme	Self-study
28 h	32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Realisation of a comprehensive automation task with microcontrollers or PLCs according to the proposal list with a current development system
- The contents of the corresponding lecture are intensively deepened
- The project is worked on in a group, as is usual in an industrial activity
- The group organises itself, develops a concept, presents the concept to the other groups, defines the interfaces, sets the schedule and divides up the tasks

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- Understand the structure, function and operation of a PLC, as well as the programming languages of IEC 61131-3 (1)
- programme a PLC using an IEC 61131-3 language (preferably in IL) (2)
- set up, programme and test a complex regulation or control system using PLC or microcontroller (3)

Learning objectives: Personal competence

After successfully completing this sub-module, students will be able to
acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).

Training materials offered
Tasks, structure description, script, exercises, bibliography
Literature
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Submodule		**TM abbreviation**
Programmable logic controllers		**PLC**
Person responsible	Faculty	
Prof Dr Franz Graf	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Franz Graf	in each semester	
Teaching form		
Seminar-based teaching 2 SWS, exercise component 50%		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	2 SWS	German	3

Time required:

On-campus study programme	Self-study
28 h	Preparation and follow-up: 52 h Exam preparation: 10 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Structure of a PLC • Common development systems • Assemblies, programming languages, operands, addressing • Link operations, VKE • Operating system and programme structure • Data types, batteries • Times, counters • Arithmetic, comparisons • State machines • Analogue I/O • Controller
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Understand the structure, function and operation of a PLC, as well as the programming languages of IEC 61131-3 (1) • programme a PLC with an IEC 61131-3 language (preferably in IL) (2) • set up, programme and test a complex regulation or control system using PLC or microcontroller (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, exercises with solutions, data sheets, bibliography
Teaching media
Programming tool, simulation tool, blackboard, projector
Literature
Günter Wellenreuther, Dieter Zastrow: Automation with PLC - Theory and Practice, + Teubner, Wiesbaden, 2008, ISBN 978-3-8348-0231-6 Hans Berger, Automatisieren mit STEP 7 in AWL und SCL: Speicherprogrammierbare Steuerungen SIMATIC S7-300/400, Publicis Publishing; Edition: 6. überarb. u. erw. Auflage (14. January 2009), ISBN-13 978-3895783241 http://www.mhj.de
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Systems Simulation		
Person responsible for the module	Faculty	
Prof Dr Andreas Voigt	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	System simulation	4 SWS	5

Submodule	**TM abbreviation**
System simulation	**SYS**

Person responsible	Faculty
Prof Dr Andreas Voigt	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Andreas Voigt	only in the winter semester
Teaching form	
Seminar-based teaching and practical training (approx. 60% practical training)	

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents

- Numerical simulation as a relevant part of the development process (finding the principle solution, optimisation)
- Teaching the basics of a modern and powerful simulation tool: structures, general mathematical description (network theory), numerical solution of the adequate equation system
- Working method of SIMULATION X using examples, independent development and partial programming of suitable models in different physical domains
- Summation of knowledge and experience in the step-by-step approach to a complex system

Learning objectives: Professional competence

After successfully completing this sub-module, students will be able to

- to demonstrate the function and coupling possibilities of simulation components (1)
- differentiate (1) and select (2) solution algorithms for coupled systems
- to form subsystems in a meaningful way and to define the interfaces (2)
- define new element types on the basis of physical relationships (3)

- existing multiphysical models to control and regulation components.
  expand (2)
- model (3) and simulate (2) the behaviour of complex, time-dependent technical systems
- Use analogies between physical domains to form multiphysical models (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Lecture guide
Teaching media
PC, blackboard, overhead, projector
Literature
SimulationX: Manual and element library
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Transmission systems (radio and line transmission)	

Person responsible for the module	Faculty
Prof Dr Thomas Fuhrmann	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Signals and systems Electrical circuit technology Fourier transformation Fields, waves and cables

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Transmission systems	4 SWS	5

Submodule	TM abbreviation
Transmission systems	**US**

Responsible person	Faculty
Prof Dr Thomas Fuhrmann	Electrical engineering and information technology
Teacher / Lecturer	Offer frequency
Prof Dr Thomas Fuhrmann	only in the summer semester

Teaching form
Seminar-based teaching, approx. 30% integrated practical component

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 62 h Exam preparation: 32 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Basic concepts of transmission technology • Physical transmission media, their properties, areas of application and application limits • Multiplex process, layer models, network typologies, access methods, coding, cryptography • Modulation methods and their properties • Calculation of channel capacity taking noise into account • Fundamentals of optical transmission systems • Types of optical waveguides and wave propagation • Basics Laser as transmitter and photodiodes as receiver • Examples of selected transmission systems and their areas of application • Introduction to quantum transmission • Selected chapters of the transmission technology for self-development by the students • Practical part: Development and construction of an optical data transmission system or participation in the Rohde & Schwarz case study competition • Impulses and discussions on the impact of technology on people and the environment

Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know the common transmission media and their practical applications (1) • know the most commonly used modulation methods (1) • know the common transmission methods (1) • know components and arrangements for simple optical transmission systems (1) • know the essential transmission parameters of an optical transmission system (1) • know the essential principles of a quantum transmission system (1) • design simple optical transmission systems for given boundary conditions (2) • select a suitable transmission medium for a specific transmission task (3) • select a suitable modulation method for a given transmission problem (3) • select and use a suitable method of accessing a medium (3) • select and use an appropriate error-proofing or error-correction procedure and decide on a cryptographic method for a required transmission (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • work independently, research information, analyse data, calculate circuits and systems. (3) • reflect on their own technical work. (3) • carry out targeted project work in a team. (3) • present and discuss their results. (3) • the impact of technology on people and the environment. (2)

Training materials offered
Script, exercises, bibliography, practical instructions

Teaching media
Blackboard, computer/beamer

Literature
Kammeyer; Dekorsy: Message transmission, Springer, 2017 Werner: Nachrichten-Übertragungstechnik, Vieweg, 1st edition, 2006 Fuhrmann, T.; Mottok, J.: Ethical, Intercultural and Professional Impulses Integrated into a Transmission Systems Lecture, IEEE EDUCON 2017, pp 92-95, DOI: 10.1109/ EDUCON.2017.7942829.

Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Advanced Course on Measurement and Sensor Technology (Advanced Course on Measurements and Sensor Technology)		
Person responsible for the module	Faculty	
Prof Dr Mikhail Chamonine	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Assigned submodules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Specialisation in measurement and sensor technology	4 SWS	5

Submodule		**TM abbreviation**
Specialisation in measurement and sensor technology		**VMS**
Person responsible	Faculty	
Prof Dr Mikhail Chamonine	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Mikhail Chamonine Prof. Dr Anton Horn Prof. Dr Andreas Maier	only in the winter semester	
Teaching form		
Seminar-based teaching with laboratory work		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Selected sensor principles and components • Selected measurement and sensor concepts (sensor networks, sensor fusion, digital sensor signal processing, energy harvesting, etc.) • Selected current research and development topics in the field of measurement technology and sensor technology
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • know the most important sensor principles and their application in practice (1). • Find (2), understand (3) and analyse (3) current specialist literature. • Understand current research topics in the field of measurement and sensor technology (3). • Define complex tasks and work on them independently (3). • Carry out more complex studies on current topics (3). • Prepare and present own results in a professional manner (2).

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • assess the importance of careful, independent work for your learning success (2). • assess the importance of precise development work for development success (2). • the importance good scheduling for the learning activities about the semester (2). • recognise the dangers and opportunities of teamwork in the degree course (2) (and use these in a targeted and optimal way (3). • distribute learning activities sensibly over the semester (3). • Recognise the difference between understanding and simply applying solutions (2) and take advantage of both approaches (3).
Training materials offered
Worksheets, current specialised literature
Teaching media
Blackboard, projector, laboratory experiments
Literature
IEEE Xplore Digital Library, http://ieeexplore.ieee.org
Further information on the course
If required, this course can be held in English for foreign students. It is not guaranteed that the course can be offered in every semester according to the frequency. Please compare the curriculum table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Advanced Microcontroller Technology (Advanced Microcontroller Applications)		
Person responsible for the module	Faculty	
Prof Dr Stefan Krämer	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Mandatory requirements
Lecture Microcomputer Technology

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Specialisation in microcontroller technology (Advanced Microcontroller Applications)	4 SWS	5

Submodule		**TM abbreviation**
Advanced Microcontroller Technology (Advanced Microcontroller Applications)		**VMC-B**
Person responsible	Faculty	
Prof Dr Stefan Krämer	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Stefan Krämer	in each semester	
Teaching form		
Seminar / project work (100 % exercise component)		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• Processing a project with µC (hardware+ software) • Creation of programmes in C / Assembler, if necessary realtime BS • Familiarisation with new µC families, evaluation boards, peripheral connection • Working on manageable tasks (alone or in a team for larger tasks, interdisciplinary coordination) interdisciplinary • Circuit design (analogue / digital) / PCB design / mechanical assembly (soldering of small SMD components) - Prototyping / software development (Assembler / C / RTX- Keil) • EI-WIKI entry
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Know and be able to use microcontrollers and peripherals (3) • be able to structure a small development project (2) • Estimate time and effort (1) • be able to develop parts of an overall system independently (2) • get to know new hardware and familiarise yourself with it (2) • To be able to search for, analyse and rectify errors (2) • to be able to document results (2)

- be able to present results (2)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to • systematically approach problems (2) • be able to self-critically discuss and monitor results (1) • to be able to work in a team (2)
Training materials offered
EI-Wiki (Previous projects)
Teaching media
Computer, projector, blackboard, flipchart, evaluation boards, logic analyser, microscope, 3D printer, soldering workstation, EI wiki
Literature
• Data sheets (English) of the processor used • Assembly language programming, ARM Cortex M3, Vincent Mahout, Wiley, 2012 • ARM assembly language with hardware experiments, Ara Elahi, Trevor Arjeski, Springer, 2015 • Introduction to ARM Cortex-M microcontrollers, Jonathan W. Valvano, 2015, Vol. 1 • Original English-language data sheets from the processor manufacturer
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)	Module code or no.
Wind energy	

Person responsible for the module	Faculty
Prof Dr Oliver Brückl	Electrical engineering and information technology

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Turbomachinery, fundamentals of electrical machines

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Wind energy	4 SWS	5

Submodule		TM abbreviation
Wind energy		**WMT**
Responsible person	Faculty	
Prof Dr Oliver Brückl	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Oliver Brückl Prof Dr Franz Fuchs	only in the summer semester	
Teaching form		
Seminar-based teaching with 10-15 % exercises		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
56 h	Preparation and follow-up: 70 h Exam preparation: 24 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
• History of wind energy utilisation • Meteorological basics • Circulation and flow systems • Fundamentals of atmospheric dynamics • Statistical description of the wind conditions • Mode of operation, aerodynamics and control of wind turbines • Structure, components and grid connection of wind turbines • Project planning of wind farms • Offshore wind energy utilisation • Potential and costs of wind energy
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • Be able to explain the meteorological, physical, technical and economic aspects of wind energy utilisation (1) • Be able to calculate the wind conditions and the power output of a wind turbine (2) • Understanding atmospheric dynamics and their influencing factors (1)

- The properties and applications of the various wind turbine concepts be able to explain (1)
- to be able to carry out wind field modelling (3)
- be able to prepare location analyses and estimate yields (3)

Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Script, presentation documents and exercises
Teaching media
Blackboard, computer/beamer
Literature
Hau, E.: Wind turbines - fundamentals, technology, application, economic efficiency. Springer Vieweg, Berlin, 2014 Heier, S.: Wind turbines - system design, grid integration, control. Vieweg+Teubner Verlag, Stuttgart; 2009 Gasch, R., Twele, J.: Wind Turbines - Fundamentals, Design, Planning and Operation. Vieweg+Teubner Verlag, Stuttgart, 2007
Further information on the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply

Module name (English name if applicable)		Module code or no.
Wireless Systems Design		
Person responsible for the module	Faculty	
Prof Dr Thomas Stücke	Electrical engineering and information technology	

Semester of study according to the curriculum	Study section	Module type	Labour input [ECTS credits]
	3	Centre of gravity Compulsory elective module	5

Recommended prior knowledge
Description of signals in the time and frequency domain In addition, the use of Matlab and LTSpice is helpful but not absolutely necessary

Assigned sub-modules:

No.	Designation of the submodules	Teaching scope [SWS o. UE]	Labour input [ECTS credits]
1.	Wireless Systems Design	4 SWS	5

Submodule		**TM abbreviation**
Wireless Systems Design		**WSD**
Person responsible	Faculty	
Prof Dr Thomas Stücke	Electrical engineering and information technology	
Teacher / Lecturer	Offer frequency	
Prof Dr Thomas Stücke	only in the summer semester	
Teaching form		
Seminar-based teaching, 10-15% exercises, laboratory experiments and exercises in the CIP pool		

Semester of study according to the curriculum	Teaching scope [SWS or UE]	Teaching language	Labour input [ECTS credits]
	4 SWS	German	5

Time required:

On-campus study programme	Self-study
60 h	Preparation and follow-up of lessons: 60 h, Exam preparation: 30 h

Study and examination performance
see study plan table
Authorised aids for proof of performance
see study plan table

Contents
1) Construction of modern transmitter / receiver architectures 2) Brief repetition of some communication technology basics such as digital modulation methods, multiple access methods, band spreading technology, OFDM, pulse shaping and interference in RF signal transmission 3) Circuit and system technology challenges 4) Influence of non-ideal properties of real systems 5)Effects of non-linear systems 6) Causes of noise, signal-to-noise ratio, noise figure, noise measurement and noise adjustment, especially noise in highly integrated systems 7) System design - from standard to system and block performance indicators 8)System simulations and verification measurements
Learning objectives: Professional competence
After successfully completing this sub-module, students will be able to • the switching and system technology challenges of wireless sensor networks (2) • explain the functioning of simple modulation methods, code division multiplexing and band spreading as well as RF signal transmission and interference (2)

• the structure of modern receiver architectures and the non-idealities of real receivers and explain their effects (mirror frequencies, LO leakage and DC offsets, I/Q mismatch, non-linearity) (2) • calculate noise figures and signal-to-noise ratios of systems, dimension noise adjustments and, in particular, visualise noise in highly integrated circuits (3) • Determining the system and block indicators of a receiver by means of calculations and system simulations, taking into account non-idealities (3) • Perform system verification through simulations and measurements (3)
Learning objectives: Personal competence
After successfully completing this sub-module, students will be able to acquire the competences mentioned in the introduction under "2. Learning objectives" (see page 2 of the module handbook).
Training materials offered
Slides, exercises and sample files
Teaching media
Projector, blackboard, computers in the CIP pools, experimental set-ups
Literature
Behzad Razavi: RF Microelectronics. 2nd edition, Pearson, 2014 T.H. Lee: The Design of CMOS Radio-Frequency Integrated Circuits. 2nd edition, Cambridge, 2004 D. Pozar, Microwave and RF Design of Wireless Systems, 1st ed. NewYork: John Wiley and Sons, 2001.
Further information about the course
It is not guaranteed that the course will be offered in every semester according to the frequency of offerings. can be offered. Please refer to the study plan table valid for the respective semester.

The numbers in brackets the levels to be achieved: 1 - know, 2 - can, 3 - understand and apply