Electrical Engineering and Information Technology

Bachelor Eng.

Module Manual

PO25

Valid from: SoSe24

Basic studies

Electrical Engineering 1: Basics
Electrical Engineering 2: Electrodynamics
Electrical Engineering 3: Time and Frequency Domain
Metrology 1
Metrology 2
Mathematics 1: Analysis 1
Mathematics 2: Linear Algebra
Mathematics 3: Analysis 2
Robotics
Programming
Electrical Engineering Practical
Object-Oriented Programming
Digital Technology
Mathematics 4: Statistics and Numerics
Computer Technology
Electronics
Computer-Aided Circuit Design 1
Physics Mechanics

Main studies

Digital Signal Processing
Computer-Aided Circuit Design 2
Deutsch als Fremdsprache B2 (Beschreibung auf Englisch)
Communication Technology
High Frequency Engineering
Seminar: Scientific Work
Communication networks
Power Electronics
Control Engineering
Microcontrollers
Automation
Modul 1 Study Focus
Modul 2 Study Focus
Elective Module
Seminar: Main Study
Practical semester
Bachelor's Thesis
Internet Applications
Communication Systems
Automotive Electronics Controls
Intelligent Transportation Systems
Seminar: Communication
Seminar: Automation
Real-Time Programming
Introduction to Power Train Engineering

Program Objectives

The aim of the Bachelor's degree programme
"Electrical Engineering and Information Technology" is to train young people with a versatile interest in technology who have the basic knowledge to familiarise themselves with special fields in the subject area of electrical engineering and information technology. The education includes the teaching of specialised knowledge, but also the development of social skills that make working in groups productive. In addition, the degree programme teaches methods for familiarising oneself with complex contexts and for systematic problem solving. The graduates' field of activity ranges from industry to the service sector to the public sector. The requirements for engineers in electrical engineering and information technology are very diverse. The degree programme therefore aims to convey subject-specific technical skills in the required breadth and depth. Key qualifications such as language skills, knowledge of project management as well as communication skills and time management are to be taught.

Connection of the modules

Interrelationship of the modules of the degree programme
The subject-specific and methodical fundamentals are taught in the basic study programme in the first three semesters. In the study programme "Electrical Engineering and Information Technology", special emphasis is placed on a sound and broad-based basic education in mathematics, natural sciences and technology. This includes the area of mathematics/physics with a total of six modules. Since electrical engineering can only be grasped through mathematics, these basics must be taught together with the fundamentals of electrical engineering in four modules right at the beginning. Alongside mathematics, measurement technology is the second essential approach to electrical engineering and is taught in two modules. Modern electrical engineering can no longer do without microcontroller control, so programming must be learned. The basics of programming and object-oriented programming are taught in two modules.

The first applications of programming come into play in the Robotics module. Among other classifications, electrical engineering can be divided into digital technology and analogue technology. Both branches are introduced. The basics of digital technology and, building on this, computer technologies and digital circuit design (incl. further applications of programming, communication of microcontrollers with ASICs) are taught in three modules. In computer-aided circuit design 1, the acquired programming knowledge is applied for the first time. Analogue technology, or special areas of analogue electrical engineering, after the basics of electrical engineering and mathematics, are taught in the electronics module. In the fourth semester, the specialisations in communication technology and automation technology are introduced. Furthermore, subject areas are taught that the students could apply in the practical semester (computer-aided circuit design 2: key qualifications such as language skills, knowledge of project management as well as communication skills and time management, language).

Initial specialisations take place here (communications engineering, power electronics, elective module). Students are given the opportunity to plan their own projects (key qualifications such as knowledge in project management as well as communication skills and time management). After the practical semester, knowledge is deepened (profile, control engineering, automation technology, microcontrollers, digital signal processing, high frequency technology, communication networks) and preparation for the Bachelor's thesis (seminar: scientific work) and finally the Bachelor's thesis itself. The curriculum is rounded off by the project work and the Bachelor's thesis with the associated seminar. These modules enable a further individual focus and promote the acquisition of key competences such as teamwork, self-organisation and project management. Through its modules, the degree programme thus provides an appropriate education in terms of breadth and depth for the demanding professional fields of graduates with a B. Eng. degree in "Electrical Engineering and Information Technology".

Implementation of RWU mission statement

The Electrical Engineering and Information Technology degree programme at RWU is closely aligned with the new mission statement of our university and combines specialist qualifications with interdisciplinary expertise. We attach great importance to practice-orientated, professional and partnership-based teaching, which is reflected in the close involvement of regional companies in Upper Swabia. Through the practical semester and final theses in co-operation with local companies, we offer our students direct insights into the professional world and promote their professional development.

Our degree programme is characterised by modern laboratories and special facilities such as the electromobility laboratory, where students work on real projects. A good network of study programmes within the faculty and also between the faculties offers a wide range of elective subjects and projects from various application areas of electrical engineering and computer science. This practice-orientated and application-based focus supports natural team building and promotes a culture of respectful communication - both among students and in collaboration with lecturers.

In line with our commitment to a sustainable future, the programme integrates current research findings and developments in electrical engineering. Through this close integration of teaching and research, we help to prepare our students for the challenges and opportunities of a constantly changing world. As part of our university community, they contribute to our goal of being an academic beacon in the region, shaping the future both locally and internationally.

SEM.	MODULE OVERVIEW						ECTS
1	Electrical Engineering 1: Basics 5	Mathematics 1: Analysis 1 5	Mathematics 2: Linear Algebra 5	Programming & practical course 5	Digital Technology & practical course 5	Physics Mechanics 5	**30**
2	Electrical Engineering 2: Electrodynamics 5	Metrology 1: Basics & practical course 5	Mathematics 3: Analysis 2 5	Computer-Aided Circuit Design 1 5	Computer Technology & practical course 5	Object-Oriented Programming & practical course 5	**30**
3	Electrical Engineering 3: Time and Frequency Domains 5	Robotics & practical course 5	Metrology 2: Advanced & practical course 5	Electronics 5	Mathematics 4: Statistics and Numeric & practical course 5	Electrical Engineering Practical 5	**30**
4	Computer-Aided Circuit Design 2 & practical course 5	German Language 5	Power Electronics 5	Seminar: Main Study 5	Communication Technology 5	Elective Module 5	**30**
5	Internship						**30**
6	Digital Signal Processing & practical course 5	Seminar: Scientific Work 5	Microcontroller & practical course 5	High Frequency Engineering & practical course 5	Module 2: Study Focus 5	Communication Networks 5	**30**
7	Automation & practical course 7	Control Engineering & practical course 6	Module 1: Study Focus 5	Bachelor-Thesis 12			**30**

■ Lecture subjects ■ Projects and practical courses ■ Thesis and internship

Electrical Engineering 1: Basics

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE01
Modul title:	Electrical Engineering 1: Basics
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Basics of electrical engineering - DC - Circuit calculation methods DC - AC - Complex numbers in AC - Circuit calculation methods AC - Basic circuits in AC - Three-phase AC - Sustainability
Courses:	Analysis of Electric Networks
Teaching and learning forms:	Lecture
Prerequisites for participation:	School mathematics, school physics
Applicability of the module:	SG Electrical Engineering and Information Technology SG E-Mobility and Green Energies Modul: Electrical Engineering/Physics 2: Electrodynamics Modul: Metrology 1: Basics Modul: Electrical Engineering 3: Time and Frequency Domains Modul: Electrical Engineering Practical Modul: Electronics
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	30 h per ECTS = 150 h in total 60 h for lectures 90 h for preparations
Duration of the module:	one semester
Frequency of offering:	Every semester

Literature:	Kories, Schmidt: Electrical Engineering – A Pocket Reference, Springer Führer, Heidemann, Nerreter: Grundgebiete der Elektrotechnik, Band 1, Stationäre Vorgänge. ISBN 3-445-40668-9. Band 2, Zeitabhängige Vorgänge. ISBN 3-445-40573-9, Hanser Verlag. Altmann,S; Schlayer, D.: Lehr- und Übungsbuch Elektrotechnik. 3. Auflage, 2003.Fv Fachbuchverlag Leipzig im Hanser Verlag, ISBN 3-446-22683-4 Weißgerber, Wilfried: Elektrotechnik für Ingenieure, Band 1 Gleichstromtechnik und elektromagnetisches Feld. ISBN 3-528-44616-1, E. Band 2 Wechselstromtechnik, Ortskurven, Transformator. ISBN 3-528-44617-X , Netz, Heinrich: Formeln der Elektrotechnik und Elektronik. Herausgeber: A. Möschwitzer. ISBN-10: 3446156054, ISBN-13: 978-3446156050 Carl Hanser Verlag. Schaum's Outline of Basic Circuit Analysis
Compulsory attendance:	no

Competence dimensions Electrical Engineering 1: Basics

Knowledge and understanding: Broadening of prior knowledge

The students have completed their knowledge in the following fields and are able to reflect it: electrical components: resistor, capacitor, inductor; voltage, current, AC and DC.
The students are able to calculate missing voltages or currents in electrical networks. They are able to calculate in three-phase AC circuits.

Use, application and generation of knowledge/art: Use and transfer

The students are able to design sustainable products. The importance of an economy based on sustainable products will be understood.
The students are able to use the methods of circuit analysis and to apply them on relevant circuits.

Communication and cooperation

The students work together in groups cooperative and responsible. They are able to lead small groups with simple tasks. They present topics related to a specific field clear and precise audience oriented and can evaluate presentations from others.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.
The students recognize and accept hints from others and chose appropriate solution scenarios.
The students are able to design sustainable products. The importance of an economy based on sustainable products will be understood.

Electrical Engineering 2: Electrodynamics

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE02
Modul title:	Electrical Engineering 2: Electrodynamics
Module responsible:	Prof. Dr. Thomas Doderer
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Electric charge, charge quantisation and charge conservation - Electric field - Electrostatic potential and electric voltage - Electric current and ohmic resistance - Magnetic field - Induction - Transformer - Maxwell's displacement current - Maxwell's equations - Electromagnetic waves
Courses:	Electrodynamics
Teaching and learning forms:	Lecture, Tutorial
Prerequisites for participation:	Electrical Engineering 1: Basics, Calculus 1
Applicability of the module:	Electrical Engineering and Information Technology Electromobility and Renewable Energies As a basic subject, the knowledge and skills acquired here serve all other modules of the degree programme.
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Tipler, Mosca: Physics for Scientists and Engineers Halliday, Resnick, Walker: Physics (Bachelor Edition)
Compulsory attendance:	no

Competence dimensions Electrical Engineering 2: Electrodynamics

Knowledge and understanding: Broadening of prior knowledge

They can solve electric and magnetic field problems using mathematical methods. They can calculate induction processes and use the component "transformer" in electrical circuits. Graduates can calculate electric motors and generators in basics (the field structure).
Graduates understand how the components capacitor and coil function at field level. They further understand how induction works in generators and makes electric motors run. They can describe Maxwell's equations. Furthermore, they understand how the transformer works from an induction point of view. They can describe and classify the different components of the entire electromagnetic spectrum.

Use, application and generation of knowledge/art: Use and transfer

Graduates are able to calculate electrostatic, magnetic and stationary electric flow fields. Furthermore, they can determine magnetic circuits, which form the basis for calculating chokes and transformers. Graduates recognise the components capacitor and coil from previous lectures (especially module Electrical Engineering 1) and can understand the mechanisms of action and apply them purposefully. Sustainability of the components. They can solve simple problems/tasks from electrodynamics by applying the learned general physical laws.

Communication and cooperation

Graduates work cooperatively and responsibly in groups. They can responsibly lead smaller groups with manageable tasks. In addition, they present subject-related content clearly and in a way that is appropriate for the target group and evaluate it.

Scientific / artistic self-image and professionalism

Graduates recognise their own strengths and weaknesses with regard to their course of study and develop a picture of their own development as a future graduate of the degree programme.
Graduates show willingness to take up hints from others and choose suitable approaches to solutions for themselves.
Graduates are able to design sustainable products. The importance of a sustainable economy is recognised.

Electrical Engineering 3: Time and Frequency Domain

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE03
Modul title:	Electrical Engineering 3: Time and Frequency Domain
Module responsible:	Prof. Dr.-Ing. Klaus Werner Kark
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- linear AC networks (LTI systems) - discrete spectra of periodic signals (real and complex form of the Fourier series, power, RMS value, distortion factor) - spectra of the Fourier transform (transition from the Fourier series, continuous spectra, transfer function of two ports) - transients in linear systems (differential equations and operator calculus, Laplace transform, correspondences, inverse transforms, switching processes) In addition to and with the content of the modules, students will learn sustainable work, design and management.
Courses:	4240 Circuit Analysis in Time and Frequency Domain
Teaching and learning forms:	Lecture with integrated exercises
Prerequisites for participation:	Mathematics 1: Analysis 1, Mathematics 3: Analysis 2, Electrical Engineering 1: Basics (Analysis of Electric Networks)
Applicability of the module:	SG Electrical Engineering and Information Technology SG E-Mobility and Green Energy can be used in advanced modules: Digital Signal Processing Communication Technology Microwaves Engineering / High Frequency Engineering Control Engineering
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	The workload is approx. 150 hours (of which 50 hours for courses, 100 hours for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Summer semester only

Literature:	Führer u.a. Grundgebiete der Elektrotechnik, Carl Hanser Verlag, Band 1 - 3 Moeller/Fricke /Frohne/Vaske: Grundlagen der Elektrotechnik, Band 1. B. G. Teubner Stuttgart. Netz: Formeln der Elektrotechnik und Elektronik. Herausgeber: A. Möschwitzer. Carl Hanser Verlag. Kories, Schmidt. W.: Taschenbuch der Elektrotechnik, Verlag Harri Deutsch. Wellers: Aufgabensammlung Elektrotechnik. Girardet Verlag Scheithauer: Signale und Systeme, Teubner, Stuttgart. Weber: Laplace-Transformation, Teubner, Stuttgart. Werner: Signale und Systeme, Vieweg, Wiesbaden.
Compulsory attendance:	no

Competence dimensions Electrical Engineering 3: Time and Frequency Domain

Knowledge and understanding: Broadening of prior knowledge

Graduates know how to use the integral calculus and differential calculus tool. They can explain the differences in the signal description in the time domain and in the spectral domain.
Graduates understand the relationship between the spectral bandwidth and the convergence of a Fourier series. Graduates are able to explain relationships between time functions and their spectra.
Graduates recognize the components capacitor and inductor from previous lectures (especially from the module electrical engineering 1) and can understand their effects in resonators and filters.

Use, application and generation of knowledge/art: Use and transfer

Graduates can calculate currents and voltages in concentrated RLC circuits with any time dependance. They can demonstrate the influence of bandwidth restrictions and envelope distortion of electrical signals. Graduates develop electrical circuits that meet bandwidth and bit rate requirements.

Communication and cooperation

Graduates can explain the benefits of high bandwidth when using modern communication systems.

Scientific / artistic self-image and professionalism

Based on measurable time functions, an alternative description of electrical signals in the spectral or operator domain is given by means of the complex calculations, which results in a completely new approach for the development of electrical circuits.

Metrology 1

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE04
Modul title:	Metrology 1
Module responsible:	Prof. Dr.-Ing. Raphael Ruf
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	The oscilloscope is one of the most important tool of an electrical engineer. The functions and the fields of application of this measuring device are studied in a number of experiments. Besides the fundamental measurements of frequency and amplitude, different trigger possibilities as well as signal coupling are analyzed. Moreover, characteristics of components in xy operation are, among others, recorded. Transfer functions of different two-port devices (e.g. Wien circuit) are investigated with different analogue and digital test equipment Power measurements and measuring voltages, currents and the phase leads to an understanding of the test setup and of the behaviour of a three-phase system in T- and Y- connection under symmetric and unsymmetrical load. The IEC bus experiment responds to requirements for automated measuring procedures and computer-controlled measuring devices. After students have programmed and examined the processes taking place during the data exchange between several devices, a program will be developed which automatically measures the transfer characteristic of a two-port network and shows the result graphically.
Courses:	2117 Metrology 1 2121 Metrology Practical
Teaching and learning forms:	Lectures and laboratory work
Prerequisites for participation:	-basics of electrical engineering -basics of mathematics
Applicability of the module:	- Electrical Engineering and Information Technology - Computer Science and Electrical Engineering PLUS - Electromobility and Regenerative Energies
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	30 hours per ECTS. Hence, total workload amounts to 150 hours (60 hours laboratory presence and 90 hours self study time).
Duration of the module:	one semester
Frequency of offering:	Summer semester only

Literature:	Tumanski, S.; Principles of Electrical Measurement (CRC) Führer, A.; Heidemann, K.; Nerreter, W.: Grundgebiete der Elektrotechnik (Hanser) Schrüfer, E.: Elektrische Messtechnik (Hanser)
Compulsory attendance:	no

Competence dimensions Metrology 1

Knowledge and understanding: Deepening of individual components of knowledge

Correct function and compliance with requirements of electrical parts and equipment must be controlled and verified via measurements. After the lecture the participants should be able to use measurement equipment in the different labs during their studies and later in practical work.

Starting with definitions of measurements and how to go about measuring different quantities, practical approaches to measurement activities will be presented. Evaluating possible sources of error and error propagation to the final result is very important and will be discussed. After looking at a variety of measurement devices, different measuring methods and systems as well as automated measurement will be discussed.

Use, application and generation of knowledge/art: Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Metrology 2

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE05
Modul title:	Metrology 2
Module responsible:	Prof. Dr. rer. nat. Martin Störzer
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	The lecture focuses on the following core subjects: -Properties of real electrical components such as resistors, capacitors and inductors. Finding the right component for the respective task and learning about the limits of the components, especially regarding frequency behavior. -Construction and functioning of power supplies with an emphasis on the different properties of linear regulated over switching mode power supplies. -Cooling of electronic components. -Digital frequency and time measurements. -Analog to digital and Digital to analog conversion.
Courses:	5139 Metrology 2 1816 Electronics, Practical Training
Teaching and learning forms:	Lectures and laboratory work
Prerequisites for participation:	
Applicability of the module:	- Electrical Engineering and Information Technology - Computer Science and Electrical Engineering PLUS - Electromobility and Regenerative Energies
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	30 hours per ECTS. Hence, total workload amounts to 150 hours (60 hours laboratory presence and 90 hours self study time).
Duration of the module:	one semester
Frequency of offering:	Summer semester only

Literature:	Gussow , Milton; Schaum's outline of basic electricity; McGraw-Hill; 2007 Bergmann, K.; Elektrische Messtechnik; Vieweg; 2000 Hoffmann, J.; Taschenbuch der Messtechnik, Fachbuchverlag Leipzig; 1998 Felderhoff, Freyer; Elektrische und elektronische Messtechnik; Hanser; 03 Lerch; Elektrische Messtechnik; Springer Verlag; 2004 Meyer, G.; Oszilloskope; H\"{u}thig; 1997 Muehl, Thomas; Einfuhrung in die elektrische Messtechnik; Teubner Verlag; 2006 Schmusch, W.; Elektronische Messtechnik; Vogel-Verlag; 1998 Schruefer, E.; Elektrische Messtechnik; Hanser Verlag; 2004 Profos/Pfeifer; Grundlagen der Messtechnik; Oldenbourg; 1997 Richter, W.; Elektrische Messtechnik; VDE-Verlag; 1999
Compulsory attendance:	no

Competence dimensions Metrology 2

Knowledge and understanding: Deepening of individual components of knowledge

Consolidation and practical application of the knowledge gained from the lecture Metrology 1.

Use, application and generation of knowledge/art: Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Mathematics 1: Analysis 1

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE06
Modul title:	Mathematics 1: Analysis 1
Module responsible:	Prof. Dr. rer. nat. Stefan Elser
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1. Fundamentals: Introduction of sets, Cartesian products, relations, and functions. 2. Numbers and the principle of induction: Introduction of natural numbers, integers, rational numbers, real numbers, and complex numbers. Proof by induction. 3. Sequences and series: Convergence criterions. Introduction of sine-, cosine-, and exponential function as a series. 4. Functions: Continuous functions, polynomials, trigonometric functions. 5. Differential calculus: Product-, quotient- and chain-rule. Extrema and their criterions. Taylor Polynomials. 6. Integral Calculus: Riemann-integral, fundamental theorem of calculus, partial fraction decomposition, numerical integration
Courses:	288 Analysis 1 mit Übungen
Teaching and learning forms:	Lecture with exercises
Prerequisites for participation:	Good knowledge of secondary school math
Applicability of the module:	Elektromobilität und regenerative Energien Elektrotechnik und Informationstechnik Informatik/Elektrotechnik PLUS Physical Engineering (Technik Entwicklung)
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	ca. 50h for the lectures, ca. 100h at home (working over the lecture material, preparation for the final etc.)
Duration of the module:	one semester
Frequency of offering:	Summer semester only

Literature:	Omar Hijab: "Introduction to Calculus and Classical Analysis", Springer Sterling K.Berberian: "A First Course in Real Analysis", Springer Peter Hartmann: "Mathematik für Informatiker", Vieweg und Teubner Lothar Papula: "Mathematik für Ingenieure und Naturwissenschaftler Band 1", Springer
Compulsory attendance:	no

Competence dimensions Mathematics 1: Analysis 1

Knowledge and understanding: Broadening of prior knowledge

Students have an insight of the principle workings of the following:

Number systems, sequences, series, real-valued functions, continuity, basic differential and basic integral calculus

Use, application and generation of knowledge/art: Use and transfer

Students can apply the following:

Abstract description of simple problems, basic principles to work in the topics above.

Communication and cooperation

Graduates are able to describe problem in other technical fields using correct mathematical notation. These formulas can be used to deduce own solutions and communicate these solutions or algorithms.

Graduates are able to understand mathematical solutions provided by others.

Scientific / artistic self-image and professionalism

Graduates are aware of the necessity of proper mathematical notation to solve technical problems. Graduates use mathematics to solve purposeful technical problems.

Mathematics 2: Linear Algebra

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE07
Modul title:	Mathematics 2: Linear Algebra
Module responsible:	Prof. Dr. rer. nat. Stefan Elser
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1. Fundamentals: Introduction of sets, Cartesian products, relations, and functions. 2. Vector spaces: Real value vector spaces, groups, fields, vector spaces over any field, bases, dimension, coordinate representation, inner product, and norm. 3. Systems of linear equations: Matrix representation, solution sets, Gaussian elimination, applications. 4. Linear functions: Linear functions and matrices, Gauss-Jordan algorithm, determinants, eigenvalues, and eigenvectors, change of basis, diagonalizable matrices.
Courses:	3000 Lineare Algebra mit Übungen (Vorlesung/Übung)
Teaching and learning forms:	Lecture with exercises
Prerequisites for participation:	Good knowledge of secondary school math
Applicability of the module:	Elektromobilität und regenerative Energien Elektrotechnik und Informationstechnik Informatik/Elektrotechnik PLUS Physical Engineering (Technik Entwicklung)
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	ca. 50h for the lectures, ca. 100h at home (working over the lecture material, preparation for the final etc.)
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	David Poole: "Linear Algebra: A Modern Introduction", Cengage Learning Peter Hartmann: "Mathematik für Informatiker", Hartmann, Springer Vieweg Lothar Papula:"Mathematik für Ingenieure und Naturwissenschaftler", Band 1 - 2

Compulsory attendance:	no

Competence dimensions Mathematics 2: Linear Algebra

Knowledge and understanding: Broadening of prior knowledge

Students have an insight of the principle workings of the following:

Number systems,vector spaces, systems of linear equations, solutions sets, linear functions as matrices.

Use, application and generation of knowledge/art: Use and transfer

Students can apply the following:

Abstract description of simple problems, basic principles to work in the topics above.

Communication and cooperation

Graduates are able to describe problem in other technical fields using correct mathematical notation. These formulas can be used to deduce own solutions and communicate these solutions or algorithms.

Graduates are able to understand mathematical solutions provided by others.

Scientific / artistic self-image and professionalism

Graduates are aware of the necessity of proper mathematical notation to solve technical problems. Graduates use mathematics to solve purposeful technical problems.

Mathematics 3: Analysis 2

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE08
Modul title:	Mathematics 3: Analysis 2
Module responsible:	Prof. Dr.-Ing. Frank Fechter
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	1 Real functions of several variables 1.1 Basic definitions 1.2 Differential calculus of functions of several variables 1.3 Integration of functions of several variables 2 Vector analysis 2.1 Curves in a multidimensional vector space 2.2 Surfaces in a three dimensional vector space 2.3 Line integrals 2.4 Conservative fields and potential functions 2.5 Surface integrals 2.6 Divergence and curl of a vector field 2.7 The divergence theorem and the Stokes theorem 3 Ordinary differential equations 3.1 Introduction 3.2 First order differential equations 3.3 Higher order differential equations with constant coefficients 3.4 Systems of differential equations 3.5 Numerical methods for the solution of a differential equations
Courses:	Analysis 2
Teaching and learning forms:	lecture, exercises, tutorials, self-study
Prerequisites for participation:	Mathematics 1: Analysis 1, Mathematics 2: Algebra 1
Applicability of the module:	Metreology, High Frequency Engineering, Wireless Communications, Advanced Mathematics (Master)
Prerequisites allocation ECTS:	K 90
ECTS credits:	5
Grading:	graded
Workload:	150h

Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	English books Stroud, K. A.; Booth, D. J.: Engineering mathematics. Palgrave Macmillan 2007 Jeffrey, A.: Mathematics for engineers and scientists. Chapman & Hall/CRC, 2005 Croft, A.; Davison, R.; Hargreaves M.: Engineering mathematics: a foundation for electronic, electrical, communications, and systems engineers. Prentice Hall 2001 German books Papula L.: Mathematik für Ingenieure und Naturwissenschaftler Band 2. Vieweg Verlag, Braunschweig, Wiesbaden. Papula L.: Mathematik für Ingenieure und Naturwissenschaftler Band 3. Vieweg Verlag, Braunschweig, Wiesbaden. Brauch, W.; Dreyer, H.-J.; Haacke, W.: Mathematik für Ingenieure. Teubner Verlag, Stuttgart. Burg, K.; Haf, H.; Wille, F.: Höhere Mathematik für Ingenieure. Band 1 Analysis. Teubner Verlag, Stuttgart. Further Exercises can be found in: Wenzel, H.; Heinrich, G.: Übungsaufgaben zur Analysis. Teubner Verlag, Stuttgart. Papula L.: Mathematik für Ingenieure und Naturwissenschaftler Klausur- und Übungsaufgaben. Vieweg Verlag, Braunschweig, Wiesbaden. As a reference book: Bronstein, I.; Semendjajew, K.: Taschenbuch der Mathematik. Harri Deutsch Verlag, Frankfurt (Main).
Compulsory attendance:	no

Competence dimensions Mathematics 3: Analysis 2

Knowledge and understanding: Broadening of prior knowledge

The students are able to solve exercises from the analysis of several varaibles (extreme valus problems, Integration) and problems from vector annalysis. They are ablet to solve differend kinds of orninary differential equations.

Use, application and generation of knowledge/art:

The participants can apply mathematical methods to given problems. Besides pure mathematical problems they are also able to solve elected problems from electrical engineering and physics with mathematical methods.

Communication and cooperation

The students work together in groups cooperative and responsible.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.

Robotics

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE09
Modul title:	Robotics
Module responsible:	Prof. Dr.-Ing. Konrad Wöllhaf
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Introduction, objective, history, types of robots, applications, Industrial robot as exible manufacturing tool, Social impact, Kinematics, Homogeneous transformation matrices, Complements to the homogeneous Transformation matrix, The Denavit-Hartenberg parameters, Forward, backward transformation, orientation of the robot hand, compilation of the Formulas for the transformation, Inverse transformation, Hexapod robot, path planning, motivation, path planning on axis plane, path planning in Cartesian coordinates, collision avoidance, dynamics, fundamentals, principle of of virtual work, The iterative Newton-Euler algorithm, Luh-Walker-Paul, Control, Control requirements, Control of a DC motor, implementation of the control, robot control, tasks of the robot control, main components of robot control, operation modes of a of a robot controller, programming, programming languages for robots Translated with www.DeepL.com/Translator (free version)
Courses:	
Teaching and learning forms:	Lecture and Exercises
Prerequisites for participation:	Mathematik 1: Analysis 1, Mathematik 3: Analysis 2
Applicability of the module:	Elektrotechnik und Informationstechnik Informatik & Elektrotechnik PLUS Elektromobilität und regenerative Energien Technik-Entwicklung Angewandte Informatik Wirtschaftsingenieurwesen (Technik-Management)
Prerequisites allocation ECTS:	Portfolio 50 % Examination graded 50 % Praktical Work (Lab) not graded
ECTS credits:	5

Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. Thus results in a workload of 150 h (60 h for lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	Robert J. Schilling. Fundamentals of robotics: analyisis and control. Prentice-Hall, 1990. John J. Craig. Introduction to robotics: mechanics and control. Addison-Wesley, New York, 1 edition, 1989. Weber, W. Industrieroboter Hanser-Verlag, 2019 Behrens, R. Biomechanische Grenzwerte für die sichere Mensch-Roboter-Kollaboration Springer Vieweg, 2018 Hesse, S., Greifer-Praxis: Greifer in der Handhabungstechnik Vogel, 1991 DIN EN ISO 10218-2 Industrieroboter - Sicherheitsanforderungen - Teil 2: Robotersysteme und Integration (ISO 10218-2:2011) Beuth Verlag, Betlin, 2012 Hesse, S. & Malisa, V. (Eds.) Taschenbuch Robotik - Montage - Handhabung Carl Hanser Verlag GmbH & Co. KG, 2016 Buxbaum, H.-J. (Ed.) Mensch-Roboter-Kollaboration Springer-Verlag, 2020
Compulsory attendance:	no

Competence dimensions Robotics

Knowledge and understanding: Broadening of prior knowledge

Graduates know how the individual axes of a robot must be controlled in order to enable the
the targeted movement of the robot hand in space. They are also able to transfer their knowledge of kinematics to other applications such as computer vision and 3D CAD.

Use, application and generation of knowledge/art: Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Programming

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE10
Modul title:	Programming
Module responsible:	Prof. Dr.-Ing. Lothar Berger
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Programming basics: computer, operating system, compiler - Elements of C programming: main program, variables, basic data types, operators, branching, looping - Procedures, functions, passing of parameters - Compound data types: arrays, structs, pointers - Dynamic memory - File input-output - Recursion - Enumerations - Preprocessor
Courses:	Programming
Teaching and learning forms:	Lecture; Lab - or - E-Learning: Lessons, Exercises; Homework: Practical work
Prerequisites for participation:	
Applicability of the module:	Microcontrollers, Real-Time Programming
Prerequisites allocation ECTS:	K90: Written examination; 90 minutes
ECTS credits:	5
Grading:	graded
Workload:	Presence: 48h, Self-study: 102h - or - Online: 24h, Self-study: 102h, Homework: 24h
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	Script - or - lessons, exercises, and sample solutions; and complementary: - Darnell, Peter A. und Philip E. Margolis: C: A Software Engineering Approach. Springer-Verlag, New York, 1996 (ISBN: 0-387-94675-6) - Sedgewick, Robert: Algorithms in C. Addison Wesley. 1990 (ISBN: 978-0201514254)
Compulsory attendance:	no

Competence dimensions Programming

Knowledge and understanding: Broadening of prior knowledge

Attendees learned about C programming language concepts, and applying these for implementing short programs; utilizing development tools.

Use, application and generation of knowledge/art: Use and transfer

Attendees learned about programming and implementation of basic programs using C programming language.

Communication and cooperation

Attendees learned about applying programming skills within project teams.

Scientific / artistic self-image and professionalism

Attendees learned about applying basic knowledge of procedural programming with the C programming language; as required by the more advanced subjects Microcontrollers, Real-Time Programming, and Embedded GUI

Electrical Engineering Practical

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE11
Modul title:	Electrical Engineering Practical
Module responsible:	Prof. Dr.-Ing. Raphael Ruf
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Analyzing of electrical circuits - Dimensioning of electrical circuits - Soldering course - Circuit diagram CAD - Practical handling of circuit measurements - Finding errors in electrical circuits - Choosing the right measurement device
Courses:	5891 Basic training electrical enginnering 1: fundamental circuits 7079 Basic training electrical enginnering 2: implementation and verification
Teaching and learning forms:	Laboratory work and exercises
Prerequisites for participation:	None
Applicability of the module:	- Electrical Engineering and Information Technology - Computer Science and Electrical Engineering PLUS - Electromobility and Regenerative Energies
Prerequisites allocation ECTS:	Portfolio - Grades of successfully completed parts of the course are equally weighted and comprise the final grade.
ECTS credits:	5
Grading:	graded
Workload:	30 hours per ECTS. Hence, total workload amounts to 150 hours (60 hours laboratory presence and 90 hours self study time).
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	
Compulsory attendance:	no

Competence dimensions Electrical Engineering Practical

Knowledge and understanding: Deepening of individual components of knowledge

Graduates have broadened their existing knowledge in the following fields and can not only recite technical contents, but also explain them:

- Analyzing of electrical circuits
- Dimensioning of electrical circuits
- Soldering of simple PCBs
- Circuit diagram CAD
- Practical handling of circuit measurements
- Finding errors in electrical circuits
- Choosing the right measurement device

Use, application and generation of knowledge/art: Use and transfer

Graduates can practically apply knowledge in the following fields:

- Dimensioning of electrical circuits
- Soldering of simple PCBs
- Circuit diagram CAD
- Practical handling of circuit measurements
- Finding errors in electrical circuits
- Choosing the right measurement device

Communication and cooperation

Scientific / artistic self-image and professionalism

Graduates are able to develop sustainable products. The importance of a sustainable economy is recognized.

Object-Oriented Programming

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE12
Modul title:	Object-Oriented Programming
Module responsible:	Prof. Dr. rer. nat. Martin Zeller
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	
Courses:	
Teaching and learning forms:	
Prerequisites for participation:	
Applicability of the module:	
Prerequisites allocation ECTS:	
ECTS credits:	
Grading:	
Workload:	
Duration of the module:	
Frequency of offering:	
Literature:	
Compulsory attendance:	no

Competence dimensions Object-Oriented Programming

Knowledge and understanding:

Use, application and generation of knowledge/art:

Communication and cooperation

Scientific / artistic self-image and professionalism

Digital Technology

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE13
Modul title:	Digital Technology
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Boolean algebra - Combinational circuits - Sequential circuits - Description of logic circuits - Minimization of logic - Digital systems - PLD, FPGA, etc - VHDL basics
Courses:	Digital Technology
Teaching and learning forms:	Lecture and lab.
Prerequisites for participation:	none
Applicability of the module:	SG Electrical Engineering and Information Technology SG E-Mobility and Green Energies Modul: Computer Technology Modul: Digital Practical Modul: Computer-Aided Circuit Design 1, 2 Modul: Digital Signal Processing Modul: Microcontroller
Prerequisites allocation ECTS:	Portfolio: 4 passed practicals and a K90
ECTS credits:	5
Grading:	graded
Workload:	30 h per ECTS = 150 h in total (60 h for lectures,90 h for preparations)
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Roth, C. H.: Fundamentals of Logic Design, Nelson Engineering (Englisch) Fricke, K.: Digitaltechnik - Lehr- und Übungsbuch für Elektrotechniker und Informatiker, Teubner (Deutsch)

Compulsory attendance:	yes
Reason:	During the 4 Labs.

Competence dimensions Digital Technology

Knowledge and understanding: Broadening of prior knowledge

The students have completed their knowledge in the following fields and are able to reflect it: logic minimization, combinational circuits, sequential circuits, logic devices, hardware description languages.
The students are able to design digital logics.

Use, application and generation of knowledge/art: Use and transfer

The students are able to design sustainable products. The importance of an economy based on sustainable products will be understood.
The students are able to use the methods of digital circuit design and to apply them on relevant circuits.

Communication and cooperation

The students work together in groups cooperative and responsible. They are able to lead small groups with simple tasks.
They present topics related to a specific field clear and precise audience oriented and can evaluate presentations from others.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.
The students recognize and accept hints from others and chose appropriate solution scenarios.
The students are able to design sustainable products. The importance of an economy based on sustainable products will be understood.

Mathematics 4: Statistics and Numerics

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE14
Modul title:	Mathematics 4: Statistics and Numerics
Module responsible:	Prof. Dr. Lothar Berger
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies

Module Content:	Statistics: 1 Descriptive statistics - Introduction - One-dimensional data - Multidimensional data - Ratio and index numbers 2 Probability Theory Basics - Randomness and probability - Random variables and distributions - Distribution parameters 3 Inductive statistics - Fundamentals - Point estimation - Interval estimation - Significance tests Numerics: - Repetition: sequences and series - Programming in C and simulation in MATLAB - or - Julia - Rounding and error propagation - Linear equations - Eigenvalue problem - Function approximation - Nonlinear equations - Differentiation and Integration - Initial value problem - Optimization
Courses:	Statistics Numerics
Teaching and learning forms:	Lecture; Lab or Exercises - or - E-Learning: Lessons, Exercises; Homework: Practical work
Prerequisites for participation:	Analysis 1, Analysis 2, Linear Algebra, Programming
Applicability of the module:	Control Engineering, Digital Signal Processing, Seminar Project, Labs, Bachelor Thesis
Prerequisites allocation ECTS:	PF: 50% Statistics K60, written examination, 60 minutes; 50% Numerics PA graded, practical work
ECTS credits:	5

Grading:	graded
Workload:	Presence: 48h, Self-study: 102h - or - Online: 24h, Self-study: 102h, Homework: 24h
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	Skript - oder - Lektionen, Übungen mit Musterlösungen; sowie ergänzend: - Mathematik für Ingenieure und Naturwissenschaftler Band 1, 2 und 3; Lothar Papula - Taschenbuch der Mathematik; Bronstein, Semendjajew - Bamberg et al.: Statistik, Oldenbourg-Verlag - Bamberg et al.: Statistik-Arbeitsbuch, Oldenbourg-Verlag - Bourier, G.: Wahrscheinlichkeitsrechnung und schließende Statistik : Praxisorientierte Einführung mit Aufgaben und Lösungen, Gabler Verlag - Montgomery, Runger (2014): Applied Statistics and Probability for Engineers, 6th edition, Wiley
Compulsory attendance:	no

Competence dimensions Mathematics 4: Statistics and Numerics

Knowledge and understanding: Broadening of prior knowledge

Statistics:

The students can solve scientific problems with the appropriate statistical methods. Students can statistically record quality and yield, also on the basis of a sample.

Numerics:

The students are able to solve problems of analysis and linear algebra with numerical methods. The students know numerical methods and can apply these.

Use, application and generation of knowledge/art: Use and transfer

The students are able to use the learned methods for solving given problems. Besides pure mathematical problems, also problems from physics, electrical engineering and electronics can be solved.

Communication and cooperation

The students can work target oriented, cooperative and responsible in groups.

Scientific / artistic self-image and professionalism

The students are able see their own strength and weaknesses from their studies.

Computer Technology

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE15
Modul title:	Computer Technology
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Introduction (Numbers) - Instruction Set Architecture (General) - Instruction Set Architecture (ARMv8) - Peripherals - On-Chip Bus Systems
Courses:	Computer Technology
Teaching and learning forms:	Lecture and lab.
Prerequisites for participation:	Digital Technology
Applicability of the module:	SG Electrical Engineering and Information Technology SG E-Mobility and Green Energies Modul: Digital Practical Modul: Computer-Aided Circuit Design 1, 2 Modul: Digital Signal Processing Modul: Microcontroller
Prerequisites allocation ECTS:	Portfolio: 4 passed practicals and a K90
ECTS credits:	5
Grading:	graded
Workload:	30 h per ECTS = 150 h in total 60 h for lectures 90 h for preparations
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	- M. Menge; Moderne Prozessorarchitekturen - J.L. Hennessy, D.A.Patterson; "Computer Architecture", Morgan Kaufmann Publishers
Compulsory attendance:	yes
Reason:	During the 4 Labs.

Competence dimensions Computer Technology

Knowledge and understanding: Deepening of individual components of knowledge

The students have completed their knowledge in the following fields and are able to reflect it:

- Functionality of computer systems
- Number representations within computer systems
- Peripherals of microcontrollers
- Usage of bus systems

Use, application and generation of knowledge/art: Use and transfer

The students are able to explain the principles of a computer architecture and the interaction of programs and hardware.

Communication and cooperation

The students work together in groups cooperative and responsible. They are able to lead small groups with simple tasks.

They present topics related to a specific field clear and precise audience oriented and can evaluate presentations from others.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.

The students recognize and accept hints from others and chose appropriate solution scenarios.

The students are able to design sustainable products. The importance of an economy based on sustainable products will be understood.

Electronics

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE16
Modul title:	Electronics
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Ideal and real amplifiers Inverting and non-inverting amplifier, summing and subtracting amplifiers, differentiators and integrators. Filter Diodes and Zener Diodes Bipolar Transistors Basic circuit applications with a transistor
Courses:	1815 Electronics
Teaching and learning forms:	Lecture, Exercises
Prerequisites for participation:	Electrical Engineerin 1: Basics Metrology 1: Basics
Applicability of the module:	Electrical Engineering and Information Technology E-Mobility and Green Energy
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	Graded
Workload:	30h per ETCS, totalling 150h split in 60h Lectures 90h Revision and Preparation
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Gossner, Stefan: Grundlagen der Elektronik, 3.Auflage, Shaker-Verlag. Tietze, Schenk: Halbleiterschaltungstechnik, 11. Auflage, Springer-Verlag.
Compulsory attendance:	no

Competence dimensions Electronics

Knowledge and understanding: Broadening of prior knowledge

Successful students can describe basic electronic components and circuits as well as basic analytical methods for electronic circuits. Basic components include ideal and real Operational Amplifiers , Diodes and MOS- or bipolar Transistors. Basic Circuits and filters include one active basic component.

Use, application and generation of knowledge/art: Use and transfer

Successful students can analyse the behaviour of typical circuits using manual calculation as well as computer tools such as MATLAB and PSPICE. The practical aspects of the lecture are supportet by the Electronics Lab.

Communication and cooperation

Scientific / artistic self-image and professionalism

Computer-Aided Circuit Design 1

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE17
Modul title:	Computer-Aided Circuit Design 1
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	- Understanding a design problem - Simulation of digital circuits - Synthesis of digital circuits - Verification and test of digital circuits - Set-up of the Arduino IDE - Writing a program for the Arduino - Programming an Arduino - Usage of the Arduino I/Os
Courses:	- Basic Practical Electrical Engineering: Programming of uC - Circuit Design Practical
Teaching and learning forms:	Practical
Prerequisites for participation:	- Electrical Engineering Practical - Digital Technology - Computer Technology
Applicability of the module:	SG Electrical Engineering and Information Technology SG E-Mobility and Green Energies Modul: Computer-Aided Circuit Design 2 Modul: Digital Signal Processing Modul: Microcontroller
Prerequisites allocation ECTS:	- 50% prog. VHDL - 50% prog. uC - Both, practical with written documentation
ECTS credits:	5
Grading:	graded
Workload:	30 h per ECTS = 150 h in total 60 h for lectures 90 h for preparations

Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	Gunther Lehmann, Bernhard Wunder, Manfred Selz, Schaltungsdesign mit VHDL1998, Franzis Verlag GmbH Douglas Perry; VHDL: Programming by Example
Compulsory attendance:	yes
Reason:	Lab work

Competence dimensions Computer-Aided Circuit Design 1

Knowledge and understanding: Deepening of individual components of knowledge

The students know and understand the components from digital electronics.

The students know and understand the difference of „Concurrent Design“ und „Sequential Design" and can demonstrate it by means of VHDL.

The students know and understand the difference of „Behavioral Design Style“ und „Structural Design Style" and can demonstrate it by means of VHDL.

The students know possible interactions between FPGA and microcontroller (UART).

Use, application and generation of knowledge/art: Use and transfer

The students apply the learned principles by means of simple examples.

The students will be able to judge the quality of VHDL code: testability, synchronous.

The students will be able to plan and develop an own ASIC project (working together with an uC).

Communication and cooperation

The ASIC project will be given by the lecturers the students will be able to understand and ask questions to generate the requirements and to write the specification.

The students work together in groups cooperative and responsible. They are able to lead small groups with simple tasks.

They present topics related to a specific field clear and precise audience oriented and can evaluate presentations from others.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.

The students recognize and accept hints from others and chose appropriate solution scenarios.

The students are able to design sustainable products. The importance of an economy based on sustainable products will be understood.

Physics Mechanics

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE18
Modul title:	Physics Mechanics
Module responsible:	Prof. Dr. rer. nat. habil. Thomas Doderer
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Basic studies
Module Content:	Introduction to experimental physics, to physical procedures, reduction of real facts to the essential influencing variables, definition of physical variables through measurement processes, derivation of laws from axioms and from experimental results, illustration of physics laws through experiments, acquiring the ability to convert a problem into a mathematical formula and to present it in graphic form, solving equations, deriving, integrating, being able to use the most important mathematical functions. 1. kinematics of the mass point 2. dynamics of the mass point, force, force impact, momentum 3. energy, law of conservation of energy, friction 4. law of conservation of momentum, impact processes 5. law of gravity, motion of a body around a centre of gravity 6. kinematics and dynamics of rigid bodies, angular momentum, torque 7. law of conservation of angular momentum, application to rolling and gyroscopic motion 8. free and forced oscillations, damping
Courses:	Physics 1: Mechanics
Teaching and learning forms:	Lecture, Tutorial
Prerequisites for participation:	none
Applicability of the module:	Electrical Engineering and Information Technology, Physical Engineering As a foundation subject, the knowledge and skills acquired here serve all other modules of the degree programme.
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 h (60 h for lectures, 90 h for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Tipler, Mosca: Physics for Scientists and Engineers. Halliday, Resnick, Walker: Physics (Bachelor Edition)

Compulsory attendance:	no

Competence dimensions Physics Mechanics

Knowledge and understanding: Broadening of prior knowledge

Graduates are able to reduce a real situation to the essential influencing variables and to define physical variables through measurement processes.

Use, application and generation of knowledge/art: Use and transfer

Graduates can derive laws from axioms and from experimental results and illustrate physics laws through experiments.
Furthermore, they can convert a problem into a mathematical formula and present it in graphical form. They can solve equations, derive, integrate and use the most important mathematical functions. They can solve simple problems/tasks from mechanics by applying the general physical laws they have learned.

Communication and cooperation

Graduates work cooperatively and responsibly in groups. They can responsibly lead smaller groups with manageable tasks. In addition, they present subject-related content clearly and in a way that is appropriate for the target group and evaluate it.

Scientific / artistic self-image and professionalism

Graduates recognise their own strengths and weaknesses with regard to their course of study and develop a picture of their own development as a future graduate of the degree programme.

Graduates show willingness to take up hints from others and choose suitable approaches to solutions for themselves.

Graduates are able to design sustainable products. The importance of a sustainable economy is recognised.

Digital Signal Processing

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE19
Modul title:	Digital Signal Processing
Module responsible:	Vivien Glönkler, M.Sc.
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Introduction to MATLAB, analog and discrete signals, sampling theorem and aliasing, ideal and practical sampling, properties of the LTI-system. Analysis in the time domain: discrete convolution, difference equations, FIR- and IIR-systems. Analysis in frequency domain: DFT and FFT, basics of the Cooley-Tukey algorithm, implementations in MATLAB. Definition and properties of the Z-transform, Z-transfer function, stability of discrete systems. Design of digital filters: properties of IIR- and FIR- filters, design methods of FIR-filters using window functions. IIR-filter design method: bilinear transformation, impulse invariance method. Design examples with implementation in MATLAB.
Courses:	Digital Signal Processing
Teaching and learning forms:	Lecture and Lab
Prerequisites for participation:	Electrical Engineering 3: time and frequency domain Digital Technology
Applicability of the module:	Course of studies: Electrical Engineering and Information Technology Course of studies: E-mobility and green energy Module: Regelungstechnik (MATLAB)
Prerequisites allocation ECTS:	Portfolio: written examination K60 (exam of 60mins) 70%, 4 exercises (approx. monthly) 30%
ECTS credits:	5
Grading:	graded
Workload:	A workload of 30 hours per ECTS is assumed. This results in a workload of 150 hours (60 hours of which are for courses, 90 hours for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	- Discrete-time signal processing, Alan V. Oppenheim; Ronald W. Schafer, Pearson Education, 3. ed., internat. ed., 2010 - The scientist and engineer's guide to digital signal processing, Steven W. Smith, California Technical Publishing, 1997 - Signals and Systems, Alan V. Oppenheim, Alan S. Willsky, Pearson New International Edition, 2013
Compulsory attendance:	no

Competence dimensions Digital Signal Processing

Knowledge and understanding: Deepening of individual components of knowledge

Building on the knowledge about analog signal processing from various previous lectures, graduates first learn about the properties of sampled discrete signals.

The students can reproduce the properties of sampled discrete signals and apply them in digital filters. Students can design simple digital filters.

Use, application and generation of knowledge/art: Use and transfer

Graduates can visualize the design of digital filters. They can calculate a variety of exercises. After a short repetition of the Laplace and Fourier transformations, graduates are able to use both the discrete Fourier transformations DTFT and DFT as well as the Z-transform and are able to examine the relationships in numerous MATLAB exercises accompanying the lecture.

Communication and cooperation

Graduates work cooperatively and responsibly in groups. They can responsibly lead smaller groups with manageable tasks. In addition, they present subject-related content clearly and in a way that is appropriate for the target group and assess it.

Scientific / artistic self-image and professionalism

Graduates recognize their own strengths and weaknesses about their course of study and develop a picture of their own development as a future graduate of the course.

Graduates show willingness to take up advice from others and choose suitable solutions for themselves.

Graduates can design sustainable products. The importance of a sustainable economy is recognized. They can determine the design methods for digital filters using practical circuits and calculations.

Computer-Aided Circuit Design 2

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE20
Modul title:	Computer-Aided Circuit Design 2
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	- Introduction to digital circuit design - Logic families - Logic simulation - Synthesis - IC-Test - Requirements analysis - Writing a specification
Courses:	Circuit Design
Teaching and learning forms:	lecture, practical
Prerequisites for participation:	Digital Technology Computer-Aided Circuit Design 1
Applicability of the module:	SG: Electrical Engineering and Information Technology Modul: Digital Signal Processing Modul: Microcontroller
Prerequisites allocation ECTS:	Requirements (10%) 1. Specification (10%) Simulation Sign-Off (10%) Synthesis Sign-Off (10%) Final Specification (40%) Presentation & Questions (20%)
ECTS credits:	5

Grading:	graded PF: Requirements (10%) 1. Specification (10%) Simulation Sign-Off (10%) Synthesis Sign-Off (10%) Final Specification (40%) Presentation & Questions (20%)
Workload:	150 h in total 60 h in lectures and lab 90 h for preparations
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Schaltungsdesign mit VHDL, Gunther Lehmann, Bernhard Wunder, Manfred Selz, 1998, Franzis Verlag GmbH VHDL: Programming by Example, Douglas Perry
Compulsory attendance:	yes
Reason:	Lab work

Competence dimensions Computer-Aided Circuit Design 2

Knowledge and understanding: Deepening of individual components of knowledge

The students know and can explain:
- methods to design a digital chip
- the difference of concurrent circuits and sequential circuits
- the behavioral design style and the structural design style
- testability

Use, application and generation of knowledge/art: Scientific innovation

The students apply the principles of a structured design on a complex project. They can do a requirements analysis, write a specification, do simulations and synthesize an ASIC. They can present their project.

Communication and cooperation

The project will be given by the lecturers, the students have solve it by their owns in groups. The lecturer discuss questions related to HDL with the students but gives no solutions with respect to the project.

Scientific / artistic self-image and professionalism

The students see their own strength and weakness with respect to their studies and work on a scenario for their future as an engineer.

The students are open to accept hints and ideas from colleagues.

The students are able to design sustainable products.

Deutsch als Fremdsprache B2 (Beschreibung auf Englisch)

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE21
Modul title:	Deutsch als Fremdsprache B2 (Beschreibung auf Englisch)
Module responsible:	Natalia De Pascale Speck
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Wide range of authentic text types on current and relevant topics from everyday life, work and science. 2) Training of all skills (reading, writing, listening and speaking) embedded in realistic situations and occasions. situations and occasions. 3) Intercultural awareness of the differences between different cultures and living and working in Germany.
Courses:	4631 Deutsch als Fremdsprache B2
Teaching and learning forms:	Seminar + exercises: The selection of teaching materials and activities focuses on learner autonomy and social competence. Active participation in discussions and classroom activities is requested.
Prerequisites for participation:	Solid previous knowledge of at least B1 level according to the Common European Framework of Reference for Languages. Previous knowledge certified by a placement test or by passing the B1+ course at the RWU.
Applicability of the module:	Elektrotechnik und Informationstechnik; E-Mobitity and Green Energy, Physical Engineering; Mechanical Engineering - International Project Engineering
Prerequisites allocation ECTS:	The portfolio consists of several performances in different relevant skills: Presentation, Discussion, Written Tests, Intercultural Competence Essay/Completion Reflection. 1. presentation/ monologue speaking - 25 points - 25%. 2. final test (reading comprehension, listening comprehension, grammar) - 25 points - 25 %. 3. discussion/ dialogical speaking - 25 points - 25 %. 4. written expression - 25 points - 25 %. Supplementary opportunities to improve the final grade (bonus tasks) will be announced in Moodle at the beginning of the course (prerequisite for credit is a passing grade in the specified exam).
ECTS credits:	5
Grading:	graded
Workload:	150h
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	DaF Textbooks
Compulsory attendance:	yes

Reason:	Students can basically not acquire the complex knowledge material in self-study. Moreover, the language course thrives on debate and discourse. Therefore, compulsory attendance is necessary for the success of the course. A maximum of 2 appointments per semester will be tolerated without justification. In case of illness, a doctor's certificate is requested. Additional absences for good cause must be approved in a timely manner by the director of the Language Center be approved.

Competence dimensions Deutsch als Fremdsprache B2 (Beschreibung auf Englisch)

Knowledge and understanding: Broadening of prior knowledge

Students know the required vocabulary and the corresponding grammar of the English language.

Use, application and generation of knowledge/art: Use and transfer

Graduates can, according to level B2, - communicate spontaneously and fluently with native speakers, - without major effort for both sides, - make a constructive contribution: work towards results (understand tasks and solve them appropriately), explain a point of view, respond to and, if necessary, formulate compromises and name mistakes or advantages and disadvantages, - recognise intercultural differences, address them if necessary and offer suggestions for solutions.

Communication and cooperation

Graduates can - communicate adequately in different social and intercultural contexts according to level B2: accept different language and communication styles and adapt to them to some extent, - understand the main content of complex texts on concrete and abstract topics and, in their own field of specialisation, on specialised topics, - understand the main contents of complex texts on concrete and abstract topics and, in one's own field of specialisation, also specialist discussions, - express oneself clearly and in detail on a wide range of topics, explain a viewpoint on a current explain a point of view on a topical issue and indicate the advantages and disadvantages of different options.

Scientific / artistic self-image and professionalism

Graduates can, - evaluate the structure of the target language and classify themselves, - assess which criteria for vocabulary, grammar, pronunciation and different text forms (each corresponding to level B2) as well as cultural differences.

Communication Technology

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE22
Modul title:	Communication Technology
Module responsible:	Prof. Dr.-Ing. Frank Fechter
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	1 Introduction 1.1 What is the content of communication technology? 1.2 Historical development 2 Signal Transmission 2.1 Convolution and Fourier-Transform 2.2 Correlation functions of deterministic Signals 2.3 Probability Theory 2.4 Random signals 2.5 Discrete signals 2.6 Transmission of baseband signals 2.7 Transmission of bandpass signals 3 Channel coding 3.1 Basics 3.2 Linear block codes 3.3 Hamming-limit 3.4 Cyclic codes 3.5 Convolutional codes 3.6 Treatment of burst errors 3.7 Residual errors 4 Source coding 4.1 Redundancy and irrelevancy 4.2 Basics of information theory 4.3 Methods of redundancy reduction 4.4 Irrelevancy reduction 4.5 Compression of audio signals 4.6 Speech coding 4.7 Compression of video signals
Courses:	Communication Technology
Teaching and learning forms:	Lecture, Exercise, Self-learning

Prerequisites for participation:	Electical engineering 3
Applicability of the module:	Communication networks
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	150h
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	Höher, P. A.: Grundlagen der Informationsübertragung: Von der Theorie zu Mobilfunkanwendungen. Vieweg + Teubner, 2011 Werner, M.: Information und Codierung. Grundlagen und Anwendungen. Vieweg + Teubner Verlag, 2009 Kammeyer, K.-D.: Nachrichtenübertragung. Vieweg + Teubner, 2008 Kammeyer, K.-D.: Übungen zur Nachrichtenübertragung. Vieweg + Teubner, 2009 Girod, B.,Rabenstein, R., Stenger, A.: Einführung in die Systemtheorie: Signale und Systeme in der Elektrotechnik und Informationstechnik 3. Auflage, September 2007 Ohm, J-R., Lüke, H. D.: Signalübertragung: Grundlagen der digitalen und analogen Nachrichtenübertragungssystem. 12. Auflage, Februar 2015 Klimant, H.; Piotraschke, R.; Schönfeld, D.: Informations- und Kodierungstheorie. Teubner, Wiesbaden 2006 Mildenberger, O.: Informationstheorie und Codierung. Vieweg-Verlag, Braunschweig, 1990 Reimers, U. (Hrsg.): Digitale Fernsehtechnik. Springer-Verlag, Berlin 3. Auflage 2008 (Audio- und Videocodierung aus Kapitel 3 und 4 sind für diese Vorlesung von Bedeutung)
Compulsory attendance:	no

Competence dimensions Communication Technology

Knowledge and understanding: Broadening of prior knowledge

After successful participation the students can explain important technical terms and solutions of communication technology with their own words.
They can explain how a digital signal transmission must be realized and why the achievable data rate is limited. The students can describe methods of channel coding. They are in a position to elucidate how data can be compressed and where are the limits of data compression. They are able to explain with their own words how modern methods of video, audio and speech compression work.

Use, application and generation of knowledge/art: Use and transfer

The participants are able to calculate Fourier-transforms and Correlation functions. They can determine the sampling frequency and the data rate after digitalisation of an analog signal. The students are in a position to determine signal-to-noise ratios and bit error rates. The maximum achievable bit rate of a transmission system can be determined.
They are in a position to calculate check sums of elected codes and are able to carry out an error correction and to determine the residual error rate. The participants calculate important measurands of information theory and they can determine an optimal code for different sources.

Communication and cooperation

The students work together in groups cooperative and responsible.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.

High Frequency Engineering

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE23
Modul title:	High Frequency Engineering
Module responsible:	Prof. Dr.-Ing. Klaus Werner Kark
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	electromagnetic basics (sources and fields); field theory (coordinate systems, vector algebra, vector analysis); foundations of electrodynamics (Poynting's theorem, Maxwell's equations, wave and Helmholtz equation, boundary conditions); plane waves (in dielectrics, conductors, superconductive materials); propagation effects (polarization, reflection and transmission at boundaries, diffraction); wave guides (hollow wave guides, resonators, coaxial lines); antennas (dipole radiators, antenna characteristic, gain, effective area)
Courses:	2154 Microwaves Engineering / High Frequency Engineering 2170 Microwaves Engineering / High Frequency Engineering, Practical Training
Teaching and learning forms:	lecture with integrated exercises, practical training
Prerequisites for participation:	Circuit Analysis in Time and Frequency Domain, Communication Technology
Applicability of the module:	SG Electrical Engineering and Information Technology usable in further modules: Communication Systems
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	The workload is approx. 150 hours (50 hours for courses, 100 hours for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Kark, K.W.: Antennen und Strahlungsfelder, 8. erweiterte Auflage, Vieweg, Wiesbaden 2020. Henke, H.: Elektromagnetische Felder, Springer, Berlin. Jackson, J.D.: Klassische Elektrodynamik, de Gruyter, Berlin. Meinke, H; Gundlach, F. W.: Taschenbuch der Hochfrequenztechnik, Springer, Berlin. Pehl, E.: Mikrowellentechnik, VDE Verlag, Berlin. Zinke, O.; Brunswig, H.: Lehrbuch der Hochfrequenztechnik, Springer, Berlin.

Compulsory attendance:	no

Competence dimensions High Frequency Engineering

Knowledge and understanding: Deepening of individual components of knowledge

Graduates have expanded their knowledge in the following areas and can do this too
reproduce:
- basic electromagnetic quantities (sources and fields)
- basics of field theory (coordinate systems, vector algebra, vector analysis)
- fundamentals of electrodynamics (energy law, Maxwell's equations, wave and Helmholtz equations, boundary conditions)
- plane waves (in dielectrics, conductors, superconductors)
- propagation effects (polarization, reflection and transmission at interfaces, diffraction problems)
- waveguides (hollow waveguides, resonators, coaxial lines)
- antennas (dipole radiators, antenna characteristic, gain, effective area)

Use, application and generation of knowledge/art: Use and transfer

Graduates can apply their knowledge from the following subject areas in practice:
- basic electromagnetic quantities (sources and fields)
- basics of field theory (coordinate systems, vector algebra, vector analysis)
- fundamentals of electrodynamics (energy law, Maxwell's equations, wave and Helmholtz equations, boundary conditions)
- plane waves (in dielectrics, conductors, superconductors)
- propagation effects (polarization, reflection and transmission at interfaces, diffraction problems)
- waveguides (hollow waveguides, resonators, coaxial lines)
- antennas (dipole radiators, antenna characteristic, gain, effective area)

Communication and cooperation

Due to the close interlinking of lecture and laboratory with intensive work in groups, the aspects of high-frequency technology are worked out jointly by the students

using practical examples.

Scientific / artistic self-image and professionalism

In modern data technology, high-frequency lines have to be optimized for fast transmission with high bit rates, which can significantly improve the quality of Internet connections.

Modern radio systems (cellular radio, wireless internet access, bluetooth, directional radio, satellite radio) and radar technology (traffic safety, autonomous driving) have high energy requirements, which can be significantly reduced by optimized antenna shapes (smart antennas).

Seminar: Scientific Work

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE24
Modul title:	Seminar: Scientific Work
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Besides the topic and content of this module, the students learn sustainable and economic product design. The knowledges of the basic studies will be deepened and lifted to a level that enables them to start with a bachelor thesis. Consideration of the gender studies: - know famous female engineers - critical discussion of stereotypes and structures in electrical engineering
Courses:	scientific work
Teaching and learning forms:	seminar and practical
Prerequisites for participation:	-
Applicability of the module:	Bachelor Thesis
Prerequisites allocation ECTS:	oral examination RPA: write a scientific document and present it.
ECTS credits:	5
Grading:	graded
Workload:	150 hours
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	as needed
Compulsory attendance:	no

Competence dimensions Seminar: Scientific Work

Knowledge and understanding: Deepening of individual components of knowledge

The students are able to plan a project.

Use, application and generation of knowledge/art: Use and transfer

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Communication and cooperation

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Scientific / artistic self-image and professionalism

The students are able to design sustainable products and they understand the economic importance.

Communication networks

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE25
Modul title:	Communication networks
Module responsible:	Prof. Dr.-Ing. Frank Fechter
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	1. Basics (1.1 Use of communication networks; 1.2 Classification of networks; 1.3 Basic terms; 1.4 Network topologies; 1.5 Transmission media; 1.6 Standardisation; 1.7 Layer Models) 2. Data link layer (2.1 Frame synchronisation; 2.2 Error protection; 2.3 Medium access control; 2.4 Ethernet; 2.5 WLAN) 3. Network layer (3.1 Internet protocol version 4; 3.2 Internet protocol version 6; 3.3 Routing; 3.4 Queueing theory) 4. Transport layer (4.1 Services of transport layer protocols; 4.2 Multiplex and demultiplex; 4.3 User Datagram Protocol (UDP); 4.4 Transmission Control Protocol (TCP)) 5. Application layer (5.1 Client-server-communication; 5.2 Domain Name System (DNS); 5.3 Mail; 5.4 Hypertext Transfer Protocol; 5.5 Additional applications) 6. Network security (6.1 Ciphering; 6.2 Digital signatures; 6.3 Message Authentication Codes; 6.4 Stream Cipher method; 6.5 Authentication; 6.6 Diffie-Hellman key exchange; 6.7 Transport Layer Security (TLS); 6.8 Security on network layer; 6.9 Protection against attacks from the network; 6.10 Tips for internet security)
Courses:	Communication Networks
Teaching and learning forms:	Lecture, Exercise, Self-study
Prerequisites for participation:	Basics of mathematics
Applicability of the module:	Can be the basis for Pursuing lectures of communication networks/internet
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	150h
Duration of the module:	one semester
Frequency of offering:	Every semester

Literature:	Kurose, J.; Ross, K.: Computer Networking. A Top-Down Approach. Pearson Education Limited, Harlow England 2017 Obermann, K.; Horneffer, M.: Datennetztechnologien für Next Generation Networks. 2. Auflage, Vieweg + Teubner, Wiesbaden 2013 Küveler, G.; Schwoch, D.: Informatik für Ingenieure und Naturwissenschaftler 2. Vieweg Verlag, Wiesbaden 2007 Klimant, H.; Piotraschke, R.; Schönfeld, D.: Informations- und Codierungstheorie. Teubner, Wiesbaden 2006 Werner, M.: Netze, Protokolle, Schnittstellen und Nachrichtenverkehr. Vieweg Verlag, Wiesbaden 2005 Tanenbaum A.S.: Computer Networks. Pearson Verlag, New Jersey 2003 Conrads, D.: Telekommunikation. Vieweg Verlag, Wiesbaden 2001 Mildenberger, O.: Informationstheorie und Codierung. Vieweg-Verlag, Braunschweig, 1990 Bossert M.; Breitbach, M.: Digitale Netze. Teubner Verlag, Leipzig 1999 Meinel, C.; Sack, H.:Internetworking : Technische Grundlagen und Anwendungen. Springer Verlag 2012
Compulsory attendance:	no

Competence dimensions Communication networks

Knowledge and understanding: Broadening of prior knowledge

The participants are able to explain technical terms as well as network protocols and their operating principle. Methods to protect data and networks against attacks can be outlined by the students.

Use, application and generation of knowledge/art: Use and transfer

The students are in a position to solve elected types of problems with the help of appropriate algorithms and calculation methods. Examples are the calculation of block error rate, throughput of networks or determination of the shortest path in a network and the calculation of performance characteristics of queues.

Communication and cooperation

The students work together in groups cooperative and responsible.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.

Power Electronics

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE26
Modul title:	Power Electronics
Module responsible:	Prof. Dr.-Ing. László Farkas
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	in general -basics on loads (ohmic, inductive) -basics on rectifiers and converters power semiconductors (devices) -physics of semiconductors -diode, transistor, thyristor thermic conductivity -overview -series-/ parallel-connection -losses and cooling power devices -single-pulse devices -multi-pulse devices -AC power controller applications -B2x device -B6x device (e.g. for alternator in passenger cars) -DC/DC-converter -Field orietented control (e.g. for synchronous machine with permanent magnets)
Courses:	4651 Power Electronics
Teaching and learning forms:	Lecture
Prerequisites for participation:	
Applicability of the module:	Electrical Engineering and Information Technology E-Mobility and Green Energy
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	Graded
Workload:	30h per ETCS, totalling 150h split in 60h Lectures 90h Revision and Preparation
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	K. Heumann: Grundlagen der Leistungselektronik, Teubner 2001 N. Mohan, T.M. Undeland, W.P. Robbins: Power Electronics - Converters, Applications and Design; Wiley 2003 W. Leonhard: Control of Electrical Drives ; Springer 1997 (dt.: Regelung elektrischer Antriebe, Springer 2000); J.Pollefliet: El. power control -vol.1 (Acad.press)
Compulsory attendance:	no

Competence dimensions Power Electronics

Knowledge and understanding: Broadening of prior knowledge

Use, application and generation of knowledge/art: Use and transfer

The lecture gives an overview of the most important semiconductors and devices. The students are able to describe the function of condutors and some important converters. Focus is also the application of the devices in the control of electric drives.

Communication and cooperation

Scientific / artistic self-image and professionalism

Control Engineering

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE27
Modul title:	Control Engineering
Module responsible:	Prof. Dr.-Ing. Lothar Berger
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Mathematical modeling of controlled systems in time and frequency domain; through linear transfer elements. Linear control loop: constituent parts, requirements, stability, stationary and transient behaviour. Control design, control loop synthesis; through Bode plot, pole-zero plot, frequency response based methods. Frequency response measurement and establishment of transfer function. Control design through root locus. Within the lab, application on practical set-ups: industrial process, motor control. Implementation of basic analog and digital controllers. Control design and simulation of control loop utilizing MATLAB/Simulink, and through C programming of a microcontroller.
Courses:	Control Engineering with Exercises Control Engineering Lab
Teaching and learning forms:	Lecture; Lab - or - E-Learning: Lessons, Exercises; Homework: Practical work
Prerequisites for participation:	Analysis 1, Analysis 2, Linear Algebra, Digital Signal Processing, Microcontrollers
Applicability of the module:	Bachelor Thesis
Prerequisites allocation ECTS:	K90: Written examination; 90 minutes
ECTS credits:	6
Grading:	graded
Workload:	Presence: 72h, Self-study: 108h - or - Online: 48h, Self-study: 108h, Homework: 24h
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Script - or - lessons, exercises, and sample solutions; and complementary: Macia, N. F., Thaler, G. J.: Modeling and Control of Dynamic Systems, Cengage Learning Press, W. H., Teukolsky, S. A., Numerical Recipes in C, Cambridge
Compulsory attendance:	no

Competence dimensions Control Engineering

Knowledge and understanding: Broadening of prior knowledge

Attendees learned about properly modeling industrial processes for applying basic control methods; and about designing basic control methods – like PID control.

Use, application and generation of knowledge/art: Scientific innovation

Attendees learned about theory of basic control methods design, and applying that to realistic use-cases, by implementing basic analog and digital controllers. Attendees learned about properly modeling industrial processes, based on measurements or on theory, and then based on such a model, design the controller, using basic methods. Attendees learned to investigate the closed control loop stationary and dynamic behaviour, especially considering stability. Attendees learned about control design and simulation of control loop utilizing MATLAB/Simulink, and through C programming of a microcontroller.

Communication and cooperation

Attendees learned about presenting and applying basic control methods as a systems science; aimed at interdisciplinary projects; operated within a team of scientists, engineers, designers, and economists.

Scientific / artistic self-image and professionalism

Attendees learned about economical and ecological considerations in choosing and implementing basic control methods for industrial processes.

Microcontrollers

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE28
Modul title:	Microcontrollers
Module responsible:	Prof. Dr.-Ing. Lothar Berger
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Presentation of distinctions of computers versus embedded systems; and microprocessors versus microcontrollers. Introduction to industry standard microcontrollers families 8-bit 8051 and 32-bit ARM. Presentation of specific properties and functions: program and data memory, clock generation, timers, interrupts, internal buses - I2C, SPI - and external buses - UART, USB; and usage of ADC and DAC for basic monitoring and automation. Programming and implementation of algorithms in C and assembler. Linking microcontrollers to graphical user interfaces. Within the lab, application and programming of microcontrollers for selected use cases, demonstrated by 8051 simulation, breadboard set-up, development board with peripherals; and ARM Cortex A with realtime operating system; Cortex M0 breadboard set-up, and Cortex M3 development board with peripherals.
Courses:	Microcontrollers with Exercises Microcontrollers Lab
Teaching and learning forms:	Lecture; Lab - or - E-Learning: Lessons, Exercises; Homework: Practical work
Prerequisites for participation:	Programming, Digital Technology, Computer Technology
Applicability of the module:	Control Engineering, Automation, Real-Time Programming, Project-Seminar, Bachelor Thesis
Prerequisites allocation ECTS:	RPA (PF: 50% PA graded, 50% R graded): Practical work, documented by a seminar paper and presentation
ECTS credits:	5
Grading:	graded
Workload:	Presence: 48h, Self-study: 102h - or - Online: 24h, Self-study: 102h, Homework: 24h
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	Script - or - lessons, exercises, and sample solutions
Compulsory attendance:	no

Competence dimensions Microcontrollers

Knowledge and understanding: Broadening of prior knowledge

Attendees learned about realizing distinctions of computers versus embedded systems; and microprocessors versus microcontrollers; and about describing specific properties and functions of industry standard microcontrollers families 8-bit 8051 and 32-bit ARM: program and data memory, clock generation, timers, interrupts, internal buses - I2C, SPI - and external buses - UART, USB

Use, application and generation of knowledge/art: Use and transfer

Attendees learned about programming and implementation of basic microcontrollers monitoring and automation tasks, utilizing algorithms in C and assembler, and usage of ADC and DAC; and linking microcontrollers to graphical user interfaces.

Communication and cooperation

Attendees learned about presenting and applying basic microcontrollers monitoring and automation tasks; aimed at interdisciplinary projects; operated within a team of scientists, engineers, designers, and economists.

Scientific / artistic self-image and professionalism

Attendees learned about economical and ecological considerations for implementing basic microcontrollers monitoring and automation tasks; different to implementing monitoring and automation tasks using computers, PLC, or FPGA

Automation

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE29
Modul title:	Automation
Module responsible:	Prof. Dr.-Ing. Raphael Ruf
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	- Introduction to PLC (hardware, software, functioning) using the Beckhoff CX9020 system. - Discussion of various simulated models of technical processes, e.g. pneumatic cylinder, punching and lifting tools. - Practical part is done by students themselves in the lab using a CX9020 hardware and employing the languages IL, LD, ST and FBD For practical experience 10 PLC work benches are available, each composed of a PLC(CX9020), several illuminated pushbuttons and indicators, industrial terminals including signal state indicator, and a bus coupler used to demonstrate distributed processes. The students have to perform the wiring between PLC, push buttons and indicators, simulated process and hardware processes by themselves. Software and hardware models of different complexity are available. Based on simple examples the key knowledge is solidified (binary inputs, binary outputs, counting of events (metallic contact and solid state contact), using timer function blocks, e.g. on-delay, off-delay, flashing, single pulse, and memory function blocks with set- resp. reset-dominant behaviour as well as detection of falling and rising edge of a binary signal, and PWM signal evaluation). The advanced practical part deals with common practical aspects like sequential processes using pneumatic actuators which have to be described by a displacement step diagram (double acting pneumatic cylinder, extension, retraction, wait in limit position for given time interval, automatic sequence with well defined duration cycles).
Courses:	Introduction to Automation SPS Systems SPS Systems, Practical Training
Teaching and learning forms:	Laboratory work and exercises
Prerequisites for participation:	- Digital Electronics - Electrical Engineering - Electronics
Applicability of the module:	- Electrical Engineering and Information Technology - Computer Science and Electrical Engineering PLUS - Electromobility and Regenerative Energies
Prerequisites allocation ECTS:	K90

ECTS credits:	7
Grading:	graded
Workload:	30 hours per ECTS. Hence, total workload amounts to 150 hours (60 hours laboratory presence and 90 hours self study time).
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	Borucki, Lorenz: Digitaltechnik; Teubner Verlag 2000 ISBN 3-519-46415-2 Hentschke, Siegbert: Grundzüge der Digitaltechnik; Teubner Stuttgart 1988 ISBN 3-519-02262-1 Fricke, Klaus: Digitaltechnik; Vieweg Wiesbaden 2005 ISBN 3-528-33821-X Morgenstern, Bodo: Elektronik 3 Digitale Schaltungen und Systeme; Vieweg Wiesbaden 1999 ISBN 3-528-13366-X Wuttke; Henke: Schaltsysteme Eine automatenorientierte Einführung; Pearson Studium 2003 ISBN 3-8273-7035-3 Wellenreuter; Zastro: Steuerungstechnik mit SPS; Vieweg Wiesbaden 1998 ISBN 3-528-44580-7 Wellenreuter; Zastro: Automatisieren mit SPS Theorie und Praxis; Vieweg Wiesbaden 2005 ISBN 3-528-23910-7 John; Tiegelkamp: SPS- Programmierung mit IEC 1131-3; SpringerBerlin 1995 ISBN 3-540-58635-0 Pusch, Karl: Grundkurs IEC 1131; Vogel Würzburg 1999 ISBN 3-8023-1807-2
Compulsory attendance:	no

Competence dimensions Automation

Knowledge and understanding: Deepening of individual components of knowledge

The goal of this lecture is to establish a knowledge of the mode of operation of PLCs. (Programmable logic controller). Programming of PLCs is facilitated by introducing the languages defined in IEC 1131. Focus is on digital logic and dynamic behaviour.

Use, application and generation of knowledge/art: Use and transfer

Communication and cooperation

Scientific / artistic self-image and professionalism

Modul 1 Study Focus

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE30
Modul title:	Modul 1 Study Focus
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	See electives
Courses:	See table 3 and 4 in the SPO.
Teaching and learning forms:	See electives
Prerequisites for participation:	See electives
Applicability of the module:	See electives
Prerequisites allocation ECTS:	See electives
ECTS credits:	See electives
Grading:	See electives
Workload:	See electives
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	See electives
Compulsory attendance:	no

Competence dimensions Modul 1 Study Focus

Knowledge and understanding: Broadening of prior knowledge

Use, application and generation of knowledge/art: Scientific innovation

Communication and cooperation

Scientific / artistic self-image and professionalism

Modul 2 Study Focus

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE31
Modul title:	Modul 2 Study Focus
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	See electives
Courses:	See table 3 and 4 in the SPO.
Teaching and learning forms:	See electives
Prerequisites for participation:	See electives
Applicability of the module:	See electives
Prerequisites allocation ECTS:	See electives
ECTS credits:	See electives
Grading:	See electives
Workload:	See electives
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	See electives
Compulsory attendance:	no

Competence dimensions Modul 2 Study Focus

Knowledge and understanding: Broadening of prior knowledge

Use, application and generation of knowledge/art: Scientific innovation

Communication and cooperation

Scientific / artistic self-image and professionalism

Elective Module

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE32
Modul title:	Elective Module
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	See electives
Courses:	See electives
Teaching and learning forms:	See electives
Prerequisites for participation:	See electives
Applicability of the module:	See electives
Prerequisites allocation ECTS:	See electives
ECTS credits:	See electives
Grading:	See electives
Workload:	See electives
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	See electives
Compulsory attendance:	no

Competence dimensions Elective Module

Knowledge and understanding:

Use, application and generation of knowledge/art:

Communication and cooperation

Scientific / artistic self-image and professionalism

Seminar: Main Study

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE33
Modul title:	Seminar: Main Study
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Besides the topic and content of this module, the students learn sustainable and economic product design. The knowledges of the basic studies will be deepened and lifted to a level that enables them to start with a bachelor thesis. Consideration of the gender studies: - know famous female engineers - critical discussion of stereotypes and structures in electrical engineering
Courses:	practical work
Teaching and learning forms:	practical work
Prerequisites for participation:	-
Applicability of the module:	Bachelor Thesis
Prerequisites allocation ECTS:	oral examination and report
ECTS credits:	5
Grading:	graded
Workload:	150 hours
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	as needed
Compulsory attendance:	no

Competence dimensions Seminar: Main Study

Knowledge and understanding: Deepening of individual components of knowledge

The students are able to plan a project.

Use, application and generation of knowledge/art: Use and transfer

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Communication and cooperation

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Scientific / artistic self-image and professionalism

The students are able to design sustainable products and they understand the economic importance.

Practical semester

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE34
Modul title:	Practical semester
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	Engineering work in electrical engineering relevant companies. Get to know the requirements of an industrial working environment.
Courses:	Practical semester
Teaching and learning forms:	Practical semester
Prerequisites for participation:	The lectures of the first and second semester must be completed (60 ECTS).
Applicability of the module:	SG Electrical Engineering and Information Technology SG E-Mobility and Green Energies
Prerequisites allocation ECTS:	Practical work
ECTS credits:	30
Grading:	not graded
Workload:	20 weeks for students having a pre-practical 26 weeks for students not having a pre-practical
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	as needed
Compulsory attendance:	no

Competence dimensions Practical semester

Knowledge and understanding: Deepening of individual components of knowledge

The students are able to plan and work on engineering projects in a company.

Use, application and generation of knowledge/art: Use and transfer

The students are able to plan and work on engineering projects in a company.

Communication and cooperation

The students can apply their so far achieved theoretical and practical skills in a company and present the results to an auditorium.

Scientific / artistic self-image and professionalism

The students are able to design sustainable products and understand the importance of a sustainable economics.

Bachelor's Thesis

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE35
Modul title:	Bachelor's Thesis
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies
Module Content:	The students should proof their theoretical and practical knowledges achieved so far by means of a relevant electrical engineering project. Besides the topic of the project, sustainability, economics and planning are relevant. The knowledges achieved by the studies should be proven in within scientific environment.
Courses:	Bachelor's Thesis
Teaching and learning forms:	Engineering work
Prerequisites for participation:	- Practical semester - All lectures of the first four semesters
Applicability of the module:	SG: Electrical Engineering and Information Technology SG: Electromobility and Green Energy
Prerequisites allocation ECTS:	Bachelor's Thesis and Colloquium
ECTS credits:	12
Grading:	graded
Workload:	Topic and project must be limited in a way, that it can be solved within 360 hours (12 ECTS).
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	as needed
Compulsory attendance:	no

Competence dimensions Bachelor's Thesis

Knowledge and understanding: Knowledge Comprehension

The students can define, work on, judge and explain scientific topics.

Use, application and generation of knowledge/art: Scientific innovation

The students can define, work on, judge and explain scientific topics.

Communication and cooperation

The students can prove their knowledges achieved during their studies theoretically, practically and will be able to defend it.

The students have to discuss throughout the duration of the thesis their work with others.

Scientific / artistic self-image and professionalism

The students see their own strength and weakness with respect to their studies and work on a scenario for their future as an engineer.

The students are open to accept hints and ideas from colleagues.

The students are able to design sustainable products.

Internet Applications

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE36
Modul title:	Internet Applications
Module responsible:	Prof. Dr.-Ing. Frank Fechter
Language of lecture:	english
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Internet Protocols DNS Client-Server-Programming in Java HTTP Web-Programming
Courses:	Internet-Aplications
Teaching and learning forms:	Lecture, Practical trainings, Self-study
Prerequisites for participation:	Object Oriented Programming (Java)
Applicability of the module:	
Prerequisites allocation ECTS:	PF (written 40%, practical work 60%)
ECTS credits:	5
Grading:	graded
Workload:	150h
Duration of the module:	one semester
Frequency of offering:	Summer semester only

Literature:	Tanenbaum, A. S.: Computer Networks. Prentice Hall, New Jersey, 2003 Meindel, C.; Sack, H.: Internetworking. Springer-Verlag, Berlin, Heidelberg 2012 Badach, A.; Hoffmann, E.: Technik der IP-Netze, Carl Hanser Verlag, München, 2001 Albitz, P.; Liu, C.: DNS und Bind. OReilly, Köln 2001 Agouros, K.: DNS/DHCP. Open Source Press, München 2007 Balzert, H.: Basiswissen Web-Programmierung. W3L-Verlag 2008 Detailed contributions to all topics of this lecture are available from: https://www.w3schools.com/ https://wiki.selfhtml.org/ Ullenboom, C.: Java ist auch eine Insel. 13. Auflage, Rheinwerk Verlag Bonn 2017. 12. Auflage online: http://openbook.rheinwerk-verlag.de/javainsel/ Ullenboom, C.: Java 7. Rheinwerk Verlag Bonn 2012. http://openbook.rheinwerk-verlag.de/java7/
Compulsory attendance:	no

Competence dimensions Internet Applications

Knowledge and understanding: Broadening of prior knowledge

The students are able to describe the functions of important internet protocols with their own words. They can explain how theses functions are realised. They can assign the protocols to layers of a layer model.

Use, application and generation of knowledge/art: Scientific innovation

The students are able to implement and test simple client-server applications with Java programming language. They are in a position to design internet pages with HTML, CSS and JavaScript.

Communication and cooperation

The students work together in groups cooperative and responsible.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.

Communication Systems

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE37
Modul title:	Communication Systems
Module responsible:	Prof. Dr.-Ing. Klaus Werner Kark
Language of lecture:	english
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	information theory (entropy, redundancy, channel capacity) noise in transmission systems antennas (designs, gain, effective area) transmission systems (cable, radio, radio relay and satellite systems) positioning and navigation (radar technology, radio navigation)
Courses:	3303 Communication Systems
Teaching and learning forms:	lecture + practical exercises
Prerequisites for participation:	Communication Technology
Applicability of the module:	SG Electrical Engineering and Information Technology
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded
Workload:	The workload is approx. 150 hours (of which 50 hours for courses, 100 hours for self-study (preparation and follow-up, exam preparation).
Duration of the module:	one semester
Frequency of offering:	Summer semester only
Literature:	Herter, E.; Lörcher, W.: Nachrichtentechnik, Hanser, München. Mildenberger, O.: Informationstechnik kompakt, Vieweg, Wiesbaden. Pehl, E.: Mikrowellen in der Anwendung, Hüthig, Heidelberg. Unger, H.-G.: Hochfrequenztechnik in Funk und Radar, Teubner, Stuttgart. Weidenfeller, H.: Grundlagen der Kommunikationstechnik, Teubner, Stuttgart.
Compulsory attendance:	no

Competence dimensions Communication Systems

Knowledge and understanding: Deepening of individual components of knowledge

Graduates have expanded their knowledge in the following areas and can also reproduce this knowledge:

- information theory and coding
- noise in communication systems
- basics of antenna technology
- terrestrial radio systems
- satellite systems
- radar systems

Use, application and generation of knowledge/art: Use and transfer

Communication and cooperation

The students are introduced to industrial tasks concerning planning and implementation of communications systems using complex system planning examples.

Scientific / artistic self-image and professionalism

Modern radio systems (mobile radio, wireless Internet access, bluetooth, directional radio, satellite radio) and radar technology (traffic safety, autonomous driving) place considerable demands on the development engineer. He often has to plan, develop and set up complex communication systems in international teams with an interdisciplinary approach. In addition to high professional competence, a high level of social competence is also essential.

Automotive Electronics Controls

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE38
Modul title:	Automotive Electronics Controls
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	1 Introduction 1.1 Control System Structure 1.2 Process Controlling System 1.3 Process Interfaces 1.4 Representation of Information 2 Binary Signal Treatment 2.1 Binary Signal Sources 2.2 Binary Interfaces of PLC 2.3 Debouncing of Metallic Contacts 2.4 Binary Interface Components 2.5 Ohmic-inductive Load 2.6 Modes of Operation 3 Analogue Signal Treatment 3.1 Wiring Analogue Signals 3.2 Analogue Interface Connection 3.3 Signal Adaptation 3.4 Analogue Input 3.5 Analogue Output 3.6 Superimposed Noise 4 Sensor / Actuator Characteristics 4.1 Measurement Principles 4.2 Actuating Principles 4.3 DC Drive 4.4 Linearization
Courses:	Automotive Electronic Controls
Teaching and learning forms:	Lecture + practicals
Prerequisites for participation:	Mathematics Digital Technology
Applicability of the module:	SG: Electrical Engineering and Information Technology SG: E-Mobility and Green Energies
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	graded

Workload:	30 h per ECTS = 150 h in total 60 h for lectures 90 h for preparations
Duration of the module:	one semester
Frequency of offering:	Winter semester only
Literature:	- Deutsches Vorlesungsskript - English Lecture Notes [1] Andrew S. Tanenbaum, Computernetzwerke, Prentice Hall [2] K. Etschberger, Controller-Area-Network, Hanser Verlag [3] Bosch, Kreftfahrzeugtechnisches Handbuch, Vieweg [4] K. Reif, Automobilelektronik, Vieweg
Compulsory attendance:	no

Competence dimensions Automotive Electronics Controls

Knowledge and understanding: Deepening of individual components of knowledge

The students can explain the electrical components in a car.

Use, application and generation of knowledge/art:

The students can explain the electrical components in a car.

Communication and cooperation

The students work together in groups cooperative and responsible. They are able to lead small groups with simple tasks. They present topics related to a specific field clear and precise audience oriented and can evaluate presentations from others.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements.

The students recognize and accept hints from others and chose appropriate solution scenarios.

The students are able to design sustainable products. The importance of an economy based on sustainable products will be understood.

Intelligent Transportation Systems

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE39
Modul title:	Intelligent Transportation Systems
Module responsible:	Prof. Dr.-Ing. Frank Fechter
Language of lecture:	english
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	1. Introduction 2. Navigation and positioning 3. Inducement of traffic 4. Toll collection systems 5. Basics of digital data transmission 6. Broadcast based traffic information systems 7. Car-to-X Ad-Hoc-Networks 8. Mobile communication based traffic information systems 9. Security and privacy 10. Economical, political and legal aspects
Courses:	Intelligent Transportation Systems
Teaching and learning forms:	Lecture, Self-study
Prerequisites for participation:	
Applicability of the module:	
Prerequisites allocation ECTS:	M
ECTS credits:	5
Grading:	graded
Workload:	150h
Duration of the module:	one semester
Frequency of offering:	Every semester

Literature:	World Health Organization: GLOBAL STATUS REPORT ON ROAD SAFETY, https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/ 2018 World Health Organization: Saving millions of lives. https://www.who.int/violence_injury_prevention/publications/road_traffic/saving_millions_lives_en.pdf 2011 World Health Organization: Health for the world's adolescents. 2014 Eberspächer, J.; Arnold, H.; Hertwich,R.: Das vernetzte Automobil. Hüthig Verlag 2009 Krosch, T. et al.: Automotive Internetworking. Verlag John Wiley & Sons 2012 Schnieder, E.: Verkehrsleittechnik. Springer 2007 Marsch, P.; Bulakci Ö.; Queseth, O.; Boldi, M: 5G System Design. Verlag John Wiley & Sons 2018 Mansfeld W.: Satellitenortung und Navigation. Vieweg 2004 White C. E. et al: Some map matching algorithms for personal navigation assistants. Transportation Research Part C 8 (2000) 91-108 Quddus M. A. et al: Current map-matching algorithms for transport applications: State-of-the art and future research directions.Transportation Research Part C 15 (2007) 312-328 Sommer C.; Dressler F.: Vehicular Networking. Cambridge University Press 2014 3GGP TR 22.885: Study on LTE support for Vehicle to Everything (V2X) services. www.3gpp.org, 2015. Winner, H. et al.: Handbuch Fahrerassistenzsysteme Springer-Verlag 2015 Riegelhuth, G.; Sandrock,M.: Verkehrsmanagementzentralen für Autobahnen. Springer Vieweg Wiesbaden, 2018
Compulsory attendance:	no

Competence dimensions Intelligent Transportation Systems

Knowledge and understanding: Broadening of prior knowledge

The participants are able to explain important systems of intelligent transportation with his own words, e.g. navigation, car-to-car communication, traffic information systems etc. They know the development targets of new and established systems, can explain the functional principles and assess the performance.

Use, application and generation of knowledge/art: Use and transfer

The students are in a position to solve elected problems with appropriate calculation methods and algorithms. They are able to compare alternative systems and to elaborate their strengths and weaknesses.

Communication and cooperation

The students work together in groups cooperative and responsible.

Scientific / artistic self-image and professionalism

The students know their own strength and weaknesses with respect to their study achievements. The importance of a sustainable mobility will be understood. The can explain methods of intelligent transportation systems that contribute to a sustainable mobility.

Seminar: Communication

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE40
Modul title:	Seminar: Communication
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Besides the topic and content of this module, the students learn sustainable and economic product design. The knowledges of the basic studies will be deepened and lifted to a level that enables them to start with a bachelor thesis. Consideration of the gender studies: - know famous female engineers - critical discussion of stereotypes and structures in electrical engineering
Courses:	Project-Seminar: Communication
Teaching and learning forms:	seminar and practical
Prerequisites for participation:	-
Applicability of the module:	Bachelor Thesis
Prerequisites allocation ECTS:	oral examination
ECTS credits:	5
Grading:	graded
Workload:	150 hours
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	as needed
Compulsory attendance:	no

Competence dimensions Seminar: Communication

Knowledge and understanding: Deepening of individual components of knowledge

The students are able to plan a project.

Use, application and generation of knowledge/art: Use and transfer

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Communication and cooperation

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Scientific / artistic self-image and professionalism

The students are able to design sustainable products and they understand the economic importance.

Seminar: Automation

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE41
Modul title:	Seminar: Automation
Module responsible:	Prof. Dr.-Ing. Andreas Siggelkow
Language of lecture:	english
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Besides the topic and content of this module, the students learn sustainable and economic product design. The knowledges of the basic studies will be deepened and lifted to a level that enables them to start with a bachelor thesis. Consideration of the gender studies: - know famous female engineers - critical discussion of stereotypes and structures in electrical engineering
Courses:	Project-Seminar: Automation
Teaching and learning forms:	seminar and practical
Prerequisites for participation:	-
Applicability of the module:	Bachelor Thesis
Prerequisites allocation ECTS:	oral examination
ECTS credits:	5
Grading:	graded
Workload:	150 hours
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	as needed
Compulsory attendance:	no

Competence dimensions Seminar: Automation

Knowledge and understanding: Deepening of individual components of knowledge

The students are able to plan a project.

Use, application and generation of knowledge/art: Use and transfer

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Communication and cooperation

The students are able to plan and work on a project based on their learned theoretical and practical skills.

Scientific / artistic self-image and professionalism

The students are able to design sustainable products and they understand the economic importance.

Real-Time Programming

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EIE42
Modul title:	Real-Time Programming
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Compulsory elective module
Undergraduate/Major:	Main studies
Module Content:	Architecture of modern Automatisation Systems. Specific requirements for realtime systems. Methods of Realtime Programming: Loops, time controlled programs, loops with interrupt mechnism, multitasking, fixed priority scheduling with and without preemption, time slice scheduling, earliest deadline andrate monotonic scheduling, Task and Ressource Synchronisation (Semaphores, Mutex), Intertask Communication (Queues, Events, Sockets), Interrupt Handling (deferred and direct). Timestamping and Synchronisation. Shared access for data and memory. Design criteria for realtime systems, Discussion of FreeRTOS as a realtime operating system. Design and exercises on given example applications.
Courses:	1494 Echtzeitprogrammierung, 1495 Echtzeitprogrammierung Praktikum
Teaching and learning forms:	Lecture and practical work, online simulations
Prerequisites for participation:	Basic programming skills in C
Applicability of the module:	E-Mobility and Green Energy, Electrical Engineering and Information Technology
Prerequisites allocation ECTS:	K90
ECTS credits:	5
Grading:	Graded
Workload:	30h per credit, split into 60h Lecture , 60h Preparation and Revision, 30h Exercises
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	- Wörn, Brinkschulte, Echtzeitsysteme, Springer 2005 - Qing Li, Carolyn Yao, Real-Time Concepts for Embedded Systems, CMP 2003
Compulsory attendance:	no

Competence dimensions Real-Time Programming

Knowledge and understanding: Deepening of individual components of knowledge

Successful sudents are able to describe the architecture of modern automation systems. They can describe the programming of realtime systems on the basis of realtime operating systems in C. Successful students can sketch digital data acquisition systems with hard realtime requirements, such as control loops and sampling systems.

Use, application and generation of knowledge/art: Use and transfer

Successful students are able to apply methods of realtime programming in applications of automatisation and embedded systems. They can discuss possible solutions and problems. Successful students can work with the discussed realtime operating systems and can describe their features and basic structure. They can describe and apply important task scheduling algorithms in a number of applications.

Communication and cooperation

Scientific / artistic self-image and professionalism

Introduction to Power Train Engineering

Course of study:	Electrical Engineering and Information Technology
Degree:	Bachelor of Engineering (B.Eng.)
Modul number:	EME03
Modul title:	Introduction to Power Train Engineering
Module responsible:	Prof. Dr. rer. nat. Markus Pfeil
Language of lecture:	english
Typ of module:	Mandatory module
Undergraduate/Major:	Main studies

Module Content:	Basics -efficiency ratio -mechanics: velocities, accelerations, differential equation of motion, comparison translation to rotation DC machine -mechanics, equivalent circuit, controling, supply -stability of working point -application AC machine -principle, fieldtheory -3-phase-machine Induction machine -mechanics, equivalent circuit, calculation with constant factors -slip, efficiency, heyland circle -Kloss formula, controling -application, mechanical specialities Synchronous machine -mechanics, equivalent circuit, comparison to induction machine -efficiency, phasor diagram, field oriented control, comparison to dc machine -permanent magnet synchronous machine: --mechanics, windings, torque- and currentdensity --mechanical specialities, production, materials, magnets, requirements to rotor, application Comparison DC- / AC-machine Examples -Applications for powertrain in hybrids and e-drives -challenges and requirements for mechanical integration -costs versus necessity
Courses:	5681 Introduction to Power Train Engineering
Teaching and learning forms:	Lecture, Exercises
Prerequisites for participation:	Electrical Engineerin 1: Basics Metrology 1: Basics
Applicability of the module:	Electrical Engineering and Information Technology E-Mobility and Green Energy
Prerequisites allocation ECTS:	K90
ECTS credits:	5

Grading:	Graded
Workload:	30h per ETCS, totalling 150h split in 60h Lectures 90h Revision and Preparation
Duration of the module:	one semester
Frequency of offering:	Every semester
Literature:	W. Leonhard: Control of Electrical Drives, Springer 1997 (dt.: Regelung elektrischer Antriebe, Springer 2000) J. Pollefliet: Electronic power control - vol.2: Electronic motor control, Academia press
Compulsory attendance:	no

Competence dimensions Introduction to Power Train Engineering

Knowledge and understanding: Broadening of prior knowledge

Use, application and generation of knowledge/art: Use and transfer

The lecture gives an overview of the most important basics of motion in the electric powertrain. The students are able to describe the function of the most important electrical machines together with their control in the powertrain and to give examples for application.

Communication and cooperation

Scientific / artistic self-image and professionalism

Print date: 26.02.2024