Hochschule Karlsruhe
University of
Applied Sciences

Fakultät für
Elektro- und
Informationstechnik

Module Handbook
Electrical Engineering and Information Technology – EEIB

Degree: Bachelor of Engineering (B. Eng.)

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Index

Abbreviations:

- ECTS European Credit Transfer and Accumulation System
- CP Credit Points, ECTS-Points
- h hours
- SWS semester periods per week
- SoSe Summer semester
- WiSe Winter semester
- SPO examination regulations
- HsKA Hochschule Karlsruhe – Technik und Wirtschaft
- PH Pädagogische Hochschule Karlsruhe
- EEIB Bachelor study program Electrical Engineering and Information Technology

Explanations:

Module: Combination of several courses to form a unit with a common learning objective.

Workload: Information on the workload includes the attendance times and the preparation times before and after the actual course. The workload is measured in hours (h), which result from the credits (ECTS): in the form of performance points, so-called credit points (see below).

ECTS: is credit points defined in the European Credit Transfer System (30 Credit points per ½ year. Each credit point is equivalent to 30 hours total workload

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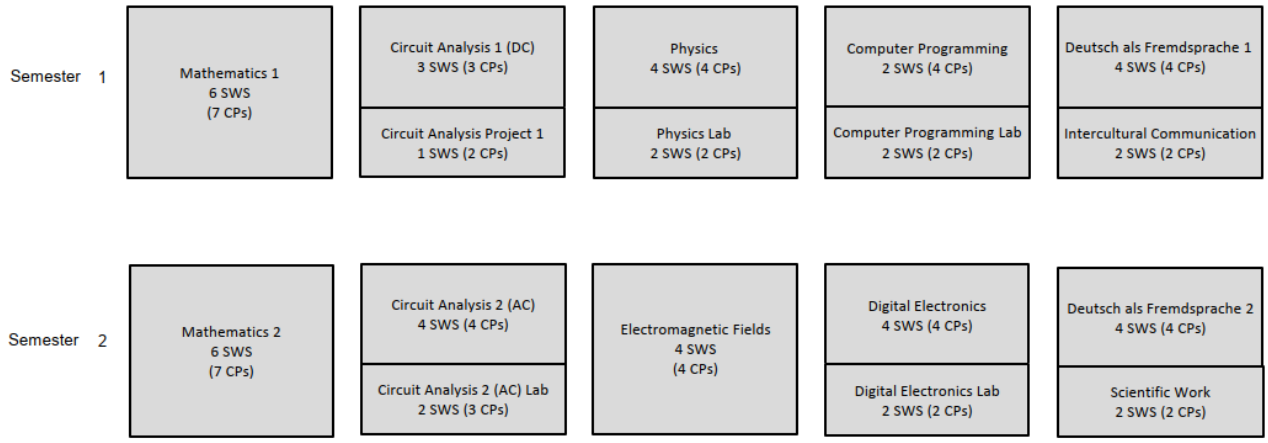
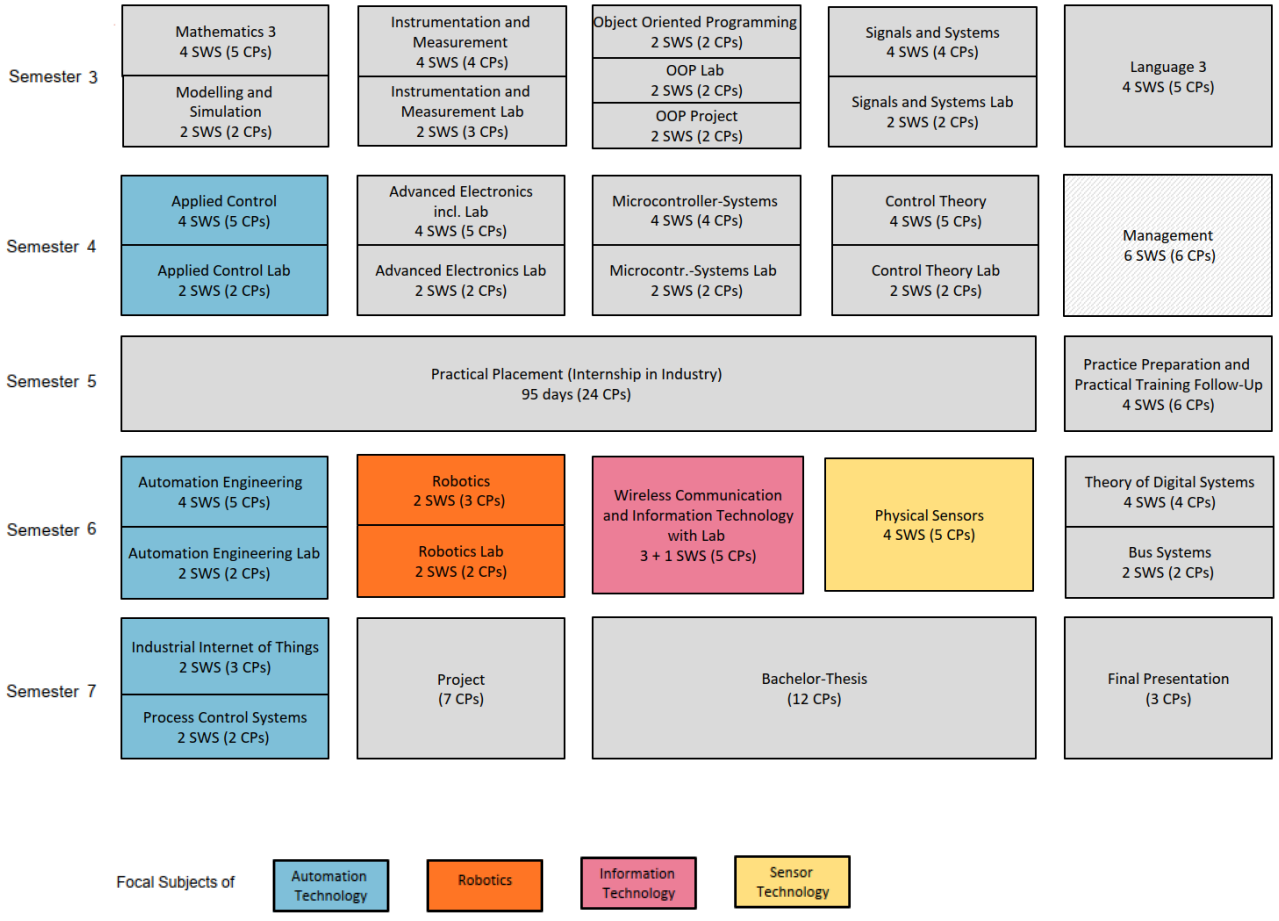
1 Module Summary

Module Summary: Basic Study Period



Module Summary: Main Study Period



2 Modules

2.1 Semester 1

- Mathematics 1
- Circuit Analysis 1
- Physics
- Programming 1
- Language 1

2.1.1 Mathematics 1

Mathematics 1

Module Summary
Module code: EEIB110
Module coordinator: Prof. Dr. Thomas Westermann
Credits (ECTS): 7 Points
Semester: 1. Semester
Pre-requisites with regard to content: none
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The participants master the elementary basics of engineering mathematics by • calculating with real numbers and performing transformations in this number range • performing mathematical proofs, especially with the help of mathematical induction • mastering the handling of complex numbers and being able to perform transformations, solve equations as well as inequalities and interpret them geometrically • solving systems of linear equations with and without parameters using the Gaussian elimination method • using the methods of vector calculus to solve geometric problems, describing direction-dependent quantities by vectors and visualizing geometric views in the plane and in space to abstract issues • calculating with elementary functions, mastering transformations of and with functions to sketch these functions • being able to interpret the limit value concept of sequences and calculating limit values of various sequences • performing limit processes for real functions: Working confidently with difference and differential quotients and mastering the derivative calculus.
Usability: This module introduces the foundations for engineering mathematics. The module is the basis for the modules Mathematics 2 and Mathematics 3.

Course: Mathematics 1
Module code: EEIB110
Lecturer: Prof. Dr. Stefan Ritter, Prof. Dr. Thomas Westermann
Scope of weekly semester hours (SWS): 6
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Sets and numbers • Mathematical proof techniques • Complex numbers • Linear systems of equations • Vector calculus and analytic geometry • Elementary functions • Sequences • Limits and continuity of functions • Derivation of functions
Recommended reading: • Westermann, T: Mathematics for Engineers (Part 1), iMath 2021, 1st Edition • Problems: iMath-Problems App, Apple App Store/Android PlayStore • www.home.hs-karlsruhe.de/~weth0002 • Goebbels, S. und Ritter, S.: Mathematik verstehen und anwenden, Springer-Spektrum 2013, 2. Auflage • Westermann, T: Mathematik für Ingenieure, Springer 2020, 8. Auflage

2.1.2 Circuit Analysis 1

Circuit Analysis 1

Module Summary
Module code: EEIB120
Module coordinator: Prof. Dr. Rainer Merz
Credits (ECTS): 5 Points
Semester: 1. Semester
Pre-requisites with regard to content: Basical mathematical and physical knowledge
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The participants learn how to analyze and calculate parameters of linear networks in respect to: Basics of electrical engineering (ohms Law, Kirchhoff Rules) • Electrical components with linear characteristics. Combinations of linear sources and components • Methods to analyze linear circuits like Superposition and transformation of linear sources • Basics and elementary circuits with operational amplifiers • Collateral project And understand how to combine linear parts and sub circuits in order to transfer the knowledge to circuits with more
Assessment: An exam with duration of 120 minutes will proof the theoretical knowledge and a technical preparation proofs the practical capability the practical
Usability: The Module Circuit Analysis gives the basics for electrical engineering, especially for the modules Circuit Analysis 2 und Electromagnetic.

Course: Circuit Analysis 1 (DC)
Module code: EEIB121
Lecturer: Prof. Dr. Rainer Merz
Scope of weekly semester hours (SWS): 3
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English

Content:

- Basic knowledge about electrical fields and charges, electrical current, electrical voltages and electrical power. Active and passive components like resistors, current sources and voltage sources
- Kirchhoff's Equivalent linear voltage and current source und equivalent resistors
- Power matching
- Superposition
- Conductance Matrix
- Basic circuits with operational amplifiers

Recommended reading:

- Mehdi Rahmani-Andebili; DC Electrical Circuit Analysis: Practice Problems, Methods, and Solutions, Springer, 2020
- Dale Patrick, Stephan Fardo: Understanding DC Circuits, Newnes, 2001
- A. Führer; K. Heidemann; W. Nerreter: Grundgebiete der Elektrotechnik 1: Stationäre Vorgänge, Hanser Verlag, 2012, 9. Auflage
- Frohne, H.; Löcherer, K.-H.; Müller, H.: Grundlagen der Elektrotechnik, Teubner, Stuttgart 2013, 23. Auflage
- Büttner, W.-E.: Grundlagen der Elektrotechnik 1, Oldenburg, München 2004

Course: Circuit Analysis Project 1

Module code: EEIB122

Lecturer: NN

Scope of weekly semester hours (SWS): 1

Semester of delivery: Winter semester

Type/mode: Excercise, Compulsory subject

Language of instruction: English

Content:

Planning and description of a first self-made electrical circuit.
Design of a circuit and calculation of parameters of needed parts
Implementation a test of the circuit.
Documentation

Recommended reading:

- Mehdi Rahmani-Andebili; DC Electrical Circuit Analysis: Practice Problems, Methods, and Solutions, Springer, 2020
- Dale Patrick, Stephan Fardo: Understanding DC Circuits, Newnes, 2001
- A. Führer; K. Heidemann; W. Nerreter: Grundgebiete der Elektrotechnik 1: Stationäre Vorgänge, Hanser Verlag, 2012, 9. Auflage
- Frohne, H.; Löcherer, K.-H.; Müller, H.: Grundlagen der Elektrotechnik, Teubner, Stuttgart 2013, 23. Auflage
- Büttner, W.-E.: Grundlagen der Elektrotechnik 1, Oldenburg, München 2004Tietze, U.; Schenk, Ch.; Gamm, E.: Halbleiter-Schaltungstechnik, Springer Verlag, Berlin, 2016, 15.Auflage

2.1.3 Physics

Physics

Module Summary
Module code: EEIB130
Module coordinator: Prof. Dr. Christian Karnutsch
Credits (ECTS): 6 Points
Semester: 1. Semester
Pre-requisites with regard to content: Basic knowledge of Mathematics and Physics
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The students can apply the principles of geometrical optics, kinematics and dynamics to exemplary practical situations by implementing the formulas, relationships and basic principles conveyed in the lecture, in order to master the approach and the basic methods for solving physical problems. This enables the students to independently work on physics topics and to solve relevant questions. The physics laboratory enables students to perform basic physics experimentation techniques and to document those in a proper technical context.
Assessment: The theoretical knowledge of the physics lecture is assessed in a 120-minute exam. The practical skills in handling the measuring equipment and the laboratory experiments are assessed through colloquia and a final laboratory test (duration 45 minutes).
Usability: The lecture conveys basic understanding of physical terms such as force, energy, (angular) momentum and their laws of conservation, as well as refraction and reflection, oscillations and waves. These basic physics fundamentals and skills are necessary and helpful for numerous advanced lectures.

Course: Physics
Module code: EEIB131
Lecturer: Prof. Dr. Christian Karnutsch, Prof. Dr. Harald Sehr
Scope of weekly semester hours (SWS): 4
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Geometrical optics

• Mechanics: kinematics; dynamics • Basic terms: force, energy, momentum, angular momentum, laws of conservation, mechanical tension, strain, Hooke's law • Basics of oscillations and waves and their properties
Recommended reading: • Halliday, David; Resnick, Robert; Walker, Jearl: Fundamentals of Physics Extended; 10th Edition, Wiley • Tipler, Paul; Gene Mosca: Physics for Scientists and Engineers; 6th edition, W.H. Freeman Particularly for the field of Optics: • Hecht, Eugene: Optics; Pearson Education

Course: Physics Lab
Module code: EEIB132
Lecturer: Prof. Dr. Christian Karnutsch, Prof. Dr. Harald Sehr
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Laborartory, Compulsory subject
Language of instruction: English
Content: Experiments in the following topis: • Optical lenses and lens systems • Determination of the electron mass • Vertical falling ball viscometer • Mass moment of inertia and torsional oscillations
Recommended reading: • Smith, Walter F.: Experimental Physics: Principles and Practice for the Laboratory; CRC Press • French, Matthew: Physics Lab Experiments; Mercury Learning & Information

2.1.4 Programming 1

Programming 1

Module Summary
Module code: EEIB140
Module coordinator: Prof. Dr. Thorsten Leize
Credits (ECTS): 6 Points
Semester: 1. Semester
Pre-requisites with regard to content: In terms of content none
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
• Competencies: • The students learn to understand the structure of modern programs and the ideas of modern programming techniques. The process of creating simple algorithms and programs in C/C++ is known and can be applied. Students are able to • design programs using basic methods • implement programs in C/C++ in a structured or objectoriented way • apply basic algorithms • make use of external libraries and program parts • find and identify errors using appropriate tools • document programs • to be able to use and understand the functionality of micro controllers and general and specialised IT systems
This module is the base of several more advanced subjects in this course.
Assessment: Exam, 120 minutes. The exercises are considered passed if the exercise sheets have been successfully completed and a small project has been successfully completed
Usability: In this module, the fundamentals of the functionality of software development systems and the process flow during programming are laid. In particular, emphasis is placed on bringing out the peculiarities of digital computational processes (Finiteness and digitality of the value ranges and the system) in programming tasks.

Course: Computer Programming
Module code: EEIB141
Lecturer: Prof. Dr. Thorsten Leize

Scope of weekly semester hours (SWS): 2 SWS
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Basics, hardware and software stacks, programming languages • Algorithms, C language examples • The build process: compile-link-run • Data types, variables, constants • Operators, terms and statements • Control statements, conditions, loops • Functions and their parameters • Pointers, pointer arithmetics, arrays • Structures
Recommended reading/ Development Software • See Ilias

Course: Computer Programming Lab
Module code: EEIB142
Lecturer: Prof. Dr. Thorsten Leize
Scope of weekly semester hours (SWS): 2 SWS
Semester of delivery: Winter semester
Type/mode: Excercises, Compulsory subject
Language of instruction: English
Content: The Exercises are done in one of the computer labs. Competencies to achieve are: • Know how to use development tools • Being able to design and implement C and C++ programs. Testing, error correction • Being able to create small algorithms
Recommended reading/Development Software: • See ILIAS

2.1.5 Language 1

Language 1

Module Summary
Module code: EEIB150
Module coordinator: IFS
Credits (ECTS): 6 Points
Semester: 1. Semester
Pre-requisites with regard to content:
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The competencies result from the module descriptions of the modules German as a Foreign Language, which are offered by the Institute for Foreign Languages (IFS) at the University of Karlsruhe. The module descriptions can be viewed at www.h-ka.de/en/study/additional-skills/languages/deutsch
Assessment: The work performed at the Institute for Foreign Languages is recognized as an assessment. The assessments of the individual modules are listed in the module descriptions at www.h-ka.de/en/study/additional-skills/languages/deutsch A portfolio must be created for the Intercultural Communication course. Duration: 1 semester.

Course: Deutsch als Fremdsprache 1
Module code: EEIB151
Lecturer: Lecturers and lecturers at the Institute for Foreign Languages
Scope of weekly semester hours (SWS): 4
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: German
Content: The content for the modules German as a Foreign Language A1.1, German as a Foreign Language A1.2, German as a Foreign Language A2.1, German as a Foreign Language A2.2 are included in the module descriptions under the module descriptions can be found at www.h-ka.de/en/study/additional-skills/languages/deutsch
Recommended reading: The scripts and books used are announced by the respective lecturers and lecturers at the IFS.

Course: Intercultural Communication
Module code: EEIB152
Lecturer: Prof. Dr. Andrea Cnyrim
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • to be announced
Recommended reading: • to be announced

2.2 Semester 2

- Mathematics 2
- Circuit Analysis 2
- Electromagnetic Fields
- Digital Electronics
- Language 2

2.2.1 Mathematics 2

Mathematics 2

Module Summary
Module code: EEIB210
Module coordinator: Prof. Dr. Thomas Westermann
Credits (ECTS): 7 Points
Semester: 2. Semester
Pre-requisites with regard to content: Mathematics I
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The participants can understand and interpret mathematically formulated issues. They can apply the concepts taught to unknown tasks by • recognizing and solving eigenvalue problems • determining and interpreting mapping matrices, null spaces, and image spaces of linear mappings • applying matrix or determinant rules to solve systems of linear equations • explaining the concept of integration and solve unknown integrals, as well as solving type integrals using the product rule or the substitution rule • explaining the concept of improper integrals and calculate them • explaining number series and function series and applying convergence rules • calculating and interpreting Taylor and Fourier series of given functions. • recognizing various first-order differential equations and solving them reliably using the methods presented to be able to apply the mathematical tools in engineering subjects and in practice.
Assessment: Exam, 120 minutes
Usability: Provide mathematical methods for use in e.g. Electromagnetic Fields, Signals and Systems.

Course: Higher Mathematics 2
Module code: EITB211
Lecturer: Prof. Dr. Stefan Ritter, Prof. Dr. Thomas Westermann
Scope of weekly semester hours (SWS): 6
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English

Content: • Matrices • Linear mappings • Eigenvalue problems • Integral calculus • Improper integrals • Series • Taylor series • Fourier series • First order differential equations
Recommended reading: • Westermann, T: Mathematics for Engineers (Part 2), iMath 2021, 1st Edition • Problems: iMath-Problems App, Apple App Store/Android PlayStore • www.home.hs-karlsruhe.de/~weth0002 • Goebbels, S. und Ritter, S.: Mathematik verstehen und anwenden, Springer-Spektrum 2013, 2. Auflage • Westermann, T: Mathematik für Ingenieure, Springer 2020, 8. Auflage

2.2.2 Circuit Analysis 2

Circuit Analysis 2

Module Summary
Module code: EEIB220
Module coordinator: Prof. Dr. Alfons Klönne
Credits (ECTS): 4 Points
Semester: 2. Semester
Pre-requisites with regard to content: Competencies acquired in lectures Mathematics 1 and Circuit Analysis 1
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: Participants will be able to describe and analyze Alternating Current (AC) circuits. After having successfully completed the course, they should • be able to describe periodic AC signals • can determine arithmetic mean and root mean square values of AC signals • understand how to transfer time invariant sinusoidal functions into complex vectors • be able to describe AC Circuits under steady state condition • know how to analyze AC circuits by complex RLC circuit analysis

• be endued with the transfer function of AC circuits • understand and apply Bode diagrams • know the criteria of resonant circuits • understand the principle of Three-Phase circuits • be able to calculate the power in AC circuits and Three-Phase circuits in order to develop an deepened understanding of electric systems that are widely used in communication and power system engineering.
Assessment: The electrical energy supply is based upon alternating current technology. Therefore, this module provides the theoretical background and helps to understand its implementation. Additionally, many disciplines in electrical engineering, e.g. communication technology with radio signal transfer depend on AC signal understanding.

Course: Circuit Analysis 2 (AC)
Module code: EEIB221
Lecturer: Prof. Dr. Alfons Klönne, NN
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Sinusoidal inputs and their representations • Instantaneous, Average, and RMS Values • Impedance and Series RLC Circuits • Admittance and Parallel RLC Circuits • Transfer Function of RLC Circuits • Bode diagram • Power in AC circuits • Resonance • Three-Phase circuits
Recommended reading: • Presentations and Media on Ilias learning platform • Jacob, Michael: Advanced AC Circuits and Electronics: Principles and Applications, Herrick & Jacob Series, 2003 • Rawlins, Clay: Basic AC Circuits, Newnes, 2000

Course: Circuit Analysis 2 (AC) Lab
Module code: EEIB222
Lecturer: Sebastian Coenen

Scope of weekly semester hours (SWS): 2
Semester of delivery: Summer semester
Type/mode: Labor, Compulsory subject
Language of instruction: English
Laboratory tests to: • Characteristics of passive and active two-terminal networks • Characterization of the properties of a circuit for voltage stabilization with Zener diode • Measurement of an unknown mixed voltage • Measurement of the speed of sound with ultrasound • Construction and measurements of basic OP circuits to record their characteristic values • Measurement of complex alternating current values on RC and RLC elements • DC voltage stabilization • Basic circuits with operational amplifiers • Working with the analog oscilloscope • Frequency response of RC networks
Recommended reading: • Presentations and Media on Ilias learning platform • Jacob, Michael: Advanced AC Circuits and Electronics: Principles and Applications, Herrick & Jacob Series, 2003 • Rawlins, Clay: Basic AC Circuits, Newnes, 2000

2.2.3 Electromagnetic Fields

Electromagnetic Fields

Module Summary
Module code: EEIB230
Module coordinator: Prof. Dr. Harald Sehr
Credits (ECTS): 4 Points
Semester: 2. Semester
Pre-requisites with regard to content: Basic knowledge in Mathematics and Physics
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The students obtain a profound comprehension of electric and magnetic fields by • studying basic concepts and terms of electric and magnetic fields, • analysing and calculating magnetic circuits,

• understanding the law of induction and Lenz's law, • defining the terms capacity, inductance and mutual inductance, • understanding the static and dynamic response of circuits with resistances, capacitances and inductances, • knowing and applying the four Maxwell's equations in integral form, to be able to solve practical electromagnetic assignments based on Maxwell's equations in integral form.
Assessment: Exam, 120 minutes
Usability: The contents of the parallel lecture Mathematics 2 are applied in this module. Examples of electric and magnetic fields help students to get practice applying their mathematical knowledge.

Course: Felder
Module code: EEIB231
Lecturer: Prof. Dr. Markus Graf, Prof. Dr. Rainer Merz, Prof. Dr. Harald Sehr
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Basic Terms: electric charge, potential energy, electric field strength, electric displacement density, magnetic field strength, magnetic flux density, magnetic flux, field lines, forces in electric and magnetic fields, electric potential, voltage, current, power • Passive dipoles (resistances, capacitances, inductances), phasor systems • Static and dynamic response of circuits with resistances, capacitances and inductances, • Magnetic circuits, magnetic reluctance, magnetisation loops • Law of induction, Lenz's law • Self-inductance and mutual inductance, transformers • Calculation of electric and magnetic fields based on Maxwell's equations in integral form
Recommended reading: • Hacker, V.; Sumereder, C.: Electrical engineering: Fundamentals, DeGruyter Oldenbourg, 2020 • Lehner, G.: Electromagnetic Field Theory for Engineers and Physicists, Springer, 2010 • Halliday, D.; Resnick, R.; Walker, J.: Fundamentals of Physics Extended; 10th Edition, Wiley, 2014 • Tipler, P.; Mosca, G.: Physics for Scientists and Engineers; 6th edition, W.H. Freeman, 2021

2.2.4 Digital Electronics

Digital Electronics

Module Summary
Module code: EEIB240
Module coordinator: Prof. Dr. Philipp Nenninger
Credits (ECTS): 6 Points
Semester: 2. Semester
Pre-requisites with regard to content: High school level mathematics and physics
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: With the successful completion of the module students can design and implement digital circuits by: • Representing numbers in numeral systems with different radices • Formulating and simplifying expressions in Boolean algebra • Minimizing sequential circuits • Composing complex sequential circuits from simple logic gates • Specifying simple digital circuits using a hardware description language • Analyzing digital signals and systems in order to control systems with digital systems.
Lecture: written exam (120 min) Lab: Assessment of all projects and documentation (pass/fail)
Usability: A basic understanding of digital systems are part of the core competences of an engineer and are the foundation for a lifelong learning in this area. Digital electronics are a requirement for other fields like microcontrollers, digital signal processing and software engineering.

Course: Digital Electronics
Module code: EEIB241
Lecturer: Prof. Dr. Philipp Nenninger
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture with integrates exercices, Compulsory subject
Language of instruction: English
• Content: • Number systems

- Codes
- Boelean Algebra
- Karnaugh-Veitch-Diagrams
- Basic circuits of digital technology
- Calculation circuits
- Multiplexer
- Digital Circuits
- Derailleurs
- Shift register

Recommended reading:

- Tocci, Ronald; Widmer, Neal and Moss, Greg: Digital Systems: Principles and Applications (11th Edition), Pearson, 2010
- Ashenden, Peter J.: The Designer's Guide to VHDL. Morgan Kaufmann Publishers, 3. Edition.

Course: Digital Electronics Lab
Module code: EEIB242
Lecturer: Prof. Dr. Philipp Nenninger, Prof. Dr. Michael Bantel
Scope of weekly semester hours (SWS): 2
Semester of delivery: Summer semester
Type/mode: Labor, Compulsory subject
Language of instruction: English

Content:
Experiments on:

- Implementation of a digital circuit using a PLD
- Definition of a digital circuit using VHDL
- Definition of a circuit in the Schematic Editor
- Use of Lattice Diamond
- Test of circuits on a given hardware
- 6 experiments: Two's complement and comperator, adder and ALU, Hamming-Code, chaser lights and counter, traffic signal and 7-segment-disply, Stop watch

Recommended reading:

- See lecture.

2.2.5 Language 2

Language 2

Module Summary
Module code: EEIB250
Module coordinator: : IFS
Credits (ECTS): 6 Points
Semester: 2. Semester
Pre-requisites with regard to content: None
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The competencies result from the module descriptions of the modules German as a Foreign Language B1.1, German as a Foreign Language B1.2, German as a Foreign Language B2.1, German as a Foreign Language B2.2, which are provided by the Institute for Foreign Languages (IFS) at the Karlsruhe University of Applied Sciences. The module descriptions can be viewed at www.h-ka.de/en/study/additional-skills/languages/deutsch.
Assessment: The work performed at the Institute for Foreign Languages is recognized as an assessment. The assessments of the individual modules are listed in the module descriptions at www.h-ka.de/en/study/additional-skills/languages/deutsch The Course Scientific Work is assessed through colloquia and written reports on each laboratory test.

Course: Deutsch als Fremdsprache 2
Module code: EEIB251
Lecturer: Lecturers and lecturers at the Institute for Foreign Languages
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: German
Content: The content for the modules German as a Foreign Language B1.1, German as a Foreign Language B1.2, German as a Foreign Language B2.1, German as a Foreign Language B2.2 are included in the module descriptions under the module descriptions can be found at www.h-ka.de/en/study/additional-skills/languages/deutsch

Recommended reading: The scripts and books used are announced by the respective lecturers and lecturers at the IFS.

Course: Scientific Work
Module code: EEIB252
Lecturer: all faculty members
Scope of weekly semester hours (SWS): 2
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: Englisch
Content: The contents of the project work result from the ongoing research and project questions and are individually designed differently from semester to semester. The topics result from the course of study. The following tasks are carried out in the team: • Recognize and describe problems • Formulate objectives • Draw up a time and project plan • Research through literature and expert surveys • Interdisciplinary processing of the task • Formulate and discuss work results in project meetings • Implementation, development and construction of project templates • Create a project folder with project documentation • Prepare a technical report • Present the final result in the final presentation and represent it with arguments
Recommended reading: • to be announced

2.3 Semester 3

- Mathematics 3
- Instrumentation and Measurement
- Programming 2
- Signals and Systems
- Language 3

2.3.1 Mathematics 3

Mathematics 3

Module Summary
Module code: EEIB310
Module coordinator: Prof. Dr. Thomas Westermann
Credits (ECTS): 7 Points
Semester: 3. Semester
Pre-requisites with regard to content: Higher Mathematics 1 and 2, Electrical Engineering 1 and 2, Programming
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: Participants will be able to recognize, formulate, and confidently solve higher order linear differential equations and systems of differential equations, and apply differential and integral calculus of several variables to multidimensional problems by • formulating linear differential equations for electrical engineering problems • solving nth order linear differential equations • calculating principal vectors of a matrix • formulating and solve systems of differential equations • explaining and applying the concepts of differential calculus for functions of several variables • formulating extreme value problems for practical problems and solving them with and without constraints • calculating area integrals, line integrals and surface integrals and interpreting them in a technical context • interpreting and applying the concepts of vector analysis • applying integral theorems, interpreting the results, and applying them in electrodynamics. to be able to apply the mathematical tools learned in engineering subjects and in practice.
Assessment: Assessment: Exam, 120 minutes; Practical skills in handling simulation tasks are assessed by colloquia.
Usability: In this module, the lecture cycle "Higher Mathematics for Engineers" is completed. The students learn methods for simulation, which can be used generally for many advanced courses.

Course: Mathematics 3
Module code: EEIB311

Lecturer: Prof. Dr. Thomas Westermann, Prof. Dr. Stefan Ritter
Scope of weekly semester hours (SWS): 4
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Linear differential equations of nth order • Systems of linear differential equations • Differential calculus for functions of several real variables • Extreme value problems of several variables • Area integrals (plane, space), line integrals, surface integrals • Integral theorems and vector analysis
Recommended reading: • Westermann, T: Mathematics for Engineers (Part 2+3), iMath 2022, 1st Edition • Problems: iMath-Problems App, Apple App Store/Android PlayStore • Visualizations: www.home.hs-karlsruhe.de/weth0002 → Animations • Goebbels, S. und Ritter, S.: Mathematik verstehen und anwenden, Springer-Spektrum 2013, 2. Auflage • Westermann, T: Mathematik für Ingenieure, Springer 2020, 8. Auflage

Course: Modelling and Simulation
Module code: EEIB312
Lecturer: Prof. Dr. Thomas Westermann
Scope of weekly semester hours (SWS): 2
Semester of delivery: Wintersemester und Summer semester
Type/mode: Labor, Compulsory subject
Language of instruction: English
Content: • Introduction to the software tool and environment • Simulation tasks for setting up and solving linear ordinary differential equations (ODE) • Model creation in state form • Exercises for dealing with differential algebraic equations (DAE) in comparison to ODE • Dealing with discontinuities when solving ODE and DAE
Recommended reading: • Campbell, Chancelier, Nikoukhah: Modeling and Simulation, in: Scilab/ Scicos with Scicoslab 4.4, Springer Verlag

2.3.2 Instrumentation and Measurement

Instrumentation and Measurement

Module Summary
Module code: EEIB320
Module coordinator: Prof. Dr. Manfred Litzenburger
Credits (ECTS): 7 Points
Semester: 3. Semester
Pre-requisites with regard to content: Modules Circuit Analysis I and II, Electromagnetic Fields, Mathematics I and II
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The students are able to treat measurement tasks by • Assessing the measurement uncertainty of a measurement chain by means of error calculation and error propagation • Understanding the mode of operation of electrical measurement methods • Using the oscilloscope as a universal measurement tool • Selecting and applying electrical measurement methods according to the requirements on the measurement problem to gain a thorough and comprehensive understanding of measurement systems for conceiving and implementing complex measurement tasks.
Assessment: Exam, 120 minutes. Practical knowledge of dealing with measurement equipment and the laboratory experiments is checked by means of colloquia and written reports for the experiments.
Usability: This module presents methods and electronic circuits for measurement tasks which are applied e.g. in control theory, automation engineering, information processing and characterisation of electric and electronic devices.

Course: Instrumentation and Measurement
Module code: EEIB321
Lecturer: Prof. Dr. Manfred Litzenburger
Scope of weekly semester hours (SWS): 4
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content:

- physical quantities and units of measurements, international system of units
- sources of errors, measurement uncertainty, error propagation
- oscilloscope
- electromechanical meters
- measurement methods for DC voltage and current
- measurement methods for AC voltage and current
- measurement of non-electrical physical quantities, e.g. temperature
- operational amplifiers in measurement instrumentation
- digital signal acquisition, analog-to-digital- / digital-to-analog- conversion
- measurement standards and references
- electrical power measurement in AC and three-phase current
- simulation of measurement methods with LT-Spice

Recommended reading:

- Will be announced in the lectures

Course: Instrumentation and Measurement Lab
Module code: EEIB252
Lecturer: Prof. Dr. Manfred Litzenburger
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Labor, Compulsory subject
Language of instruction: English

Content:

- Computer-based data acquisition with digital multimeter, 2-wire- and 4-wire measurement of contact resistance, statistical data analysis
- Measurements with the digital oscilloscope, characterisation of periodic signals, FFT-analysis, chatter of switches and relays
- Temperature sensors and measurements, thermal conduction, model-based data analysis and characterisation of thermal parameters
- Fundamentals of operational amplifiers, measurement of characteristic parameters and basic amplifier circuits
- Application of operational amplifiers: integrator, differentiator, precision rectifier, measuring bridge amplification with instrumentation amplifier, lock-in amplifier
- Characterisation of AD- and DA-converters, dual slope principle, successive approximation register principle, simulations with LT-Spice

Recommended reading:

- See corresponding lecture

2.3.3 Programming 2

Programming 2

Module Summary
Module code: EEIB330
Module coordinator: Prof. Dr. Thorsten Leize
Credits (ECTS): 6 Points
Semester: 3. Semester
Pre-requisites with regard to content: Module „Programming 1“
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The students are able to design and implement object oriented programs. They understand the object oriented way of thinking and get the differences of the various programming paradigms. They can also document the software using simple UML diagrams. They know how to use different data storage approaches and understand the differences between them.
Assessment: The module is assessed by a written exam of 90 minutes. Students have to pass furthermore the lab and project by submission and acceptance of exercises.
Usability: All electrical engineers need programming skills in their career. The modules Programming 1 & 2 are the base for this.

Course: Object Oriented Programming
Module code: EEIB331
Lecturer: Prof. Dr. Thorsten Leize
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Lecture with integrated excercise, Compulsory subject
Language of instruction: English
Content: • The object oriented programming paradigm • classes, methods, inheritance, operator overloading, polymorphy, UML • Introduction to modern concepts of C++ from new standard versions 11,14 and 20.
Recommended reading:

• See Ilias

Course: OOP Lab
Module code: EEIB332
Lecturer: Prof. Dr. Thorsten Leize
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Labor, Compulsory subject
Language of instruction: English
Content: • Object oriented software, design and implementation • Exercises to EEIB331
Recommended reading: • See Ilias

Course: OOP Project
Module code: EEIB333
Lecturer: Prof. Dr. Thorsten Leize
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Projekt, Compulsory subject
Language of instruction: English
Content: • Small project to be done to the topics of EEIB331
Recommended reading: • See EEIB331 und 332

2.3.4 Signals and Systems

Signals and Systems

Module Summary
Module code: EEIB340
Module coordinator: Prof. Dr. Manfred Strohrmann
Credits (ECTS): 6 Points
Semester: 3. Semester
Pre-requisites with regard to content: Competencies acquired in lectures Mathematics 1 + 2, Physics and Analog Electronics
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: Participants will be able to describe and analyze linear, time-invariant systems in the time, Laplace, and frequency domains by • describing signals in the time domain with mathematical functions • applying the Laplace transform to continuous-time signals • reading system properties from impulse responses and transfer functions • determine spectra of energy and power signals • construct and interpret Bode diagrams of linear, time-invariant systems • to develop an interdisciplinary understanding of systems that can be used to capture, control and simulate dynamic systems.
Assessment: Exam, 120 minutes
Usability: This module lays the systems theory foundations for Control Theory as well as Modeling and Simulation. Furthermore, the module is essential for the Lecture Theory of Digital Systems.

Course: Signals and Systems
Module code: EEIB341
Lecturer: Prof. Dr. Manfred Strohrmann
Scope of weekly semester hours (SWS): 4
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
• Content: • Signals in the time domain, signal algebra, impulse function, correlation function

• Systems in the time domain, differential equation, system properties, impulse response, convolution • Signals in the Laplace domain, Laplace transformation • Systems in the Laplace domain, transfer function, switching on and switching off processes • Spectrum of signals, Fourier series, Fourier transform • Frequency response of systems • Basics of filter design
Recommended reading: • Oppenheim, Alan: Signals, Systems and Inference, Pearson, 2017 • Chaparro, Luis: Signals and Systems using MATLAB, Academic Press, 2018

Course: Signals and Systems Lab
Module code: EEIB342
Lecturer: Prof. Dr. Manfred Strohrmann
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Labor, Compulsory subject
Language of instruction: English
Content: •
Recommended reading: • Presentations and Media on Ilias learning platform • Oppenheim, Alan: Signals, Systems and Inference, Pearson, 2017 • Chaparro, Luis: Signals and Systems using MATLAB, Academic Press, 2018

2.3.5 Language 3

Language 3

Module Summary
Module code: EEIB350
Module coordinator: : IFS
Credits (ECTS): 4 Points
Semester: 3. Semester
Pre-requisites with regard to content:
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The competencies result from the module descriptions for the modules German as a Foreign Language, which are offered by the Institute for Foreign Languages (IFS) at the University of Karlsruhe. The module descriptions can be viewed at www.h-ka.de/en/study/additional-skills/languages/deutsch.
Assessment: The tests are carried out and defined by the IFS.

Course: Deutsch als Fremdsprache 3
Module code: EEIB351
Lecturer: Lecturers at the Institute for Foreign Languages
Scope of weekly semester hours (SWS): 4
Semester of delivery: Winter semester
Type/mode: Lecture, Compulsory subject
Language of instruction: German
The competencies result from the module descriptions for the modules German as a Foreign Language, which are offered by the Institute for Foreign Languages (IFS) at the University of Karlsruhe. The module descriptions can be viewed at www.h-ka.de/en/study/additional-skills/languages/deutsch.
Recommended reading: • see Website IFS • The scripts and books used are announced by the respective lecturers and lecturers at the IFS.

2.4 Semester 4

- Focal Subjects 1
- Advanced Electronics
- Microcontroller Systems
- Control Systems
- Management

2.4.1 Focal Subjects 1

Focal Subjects 1

Module Summary
Module code: EEIB410
Module coordinator: Prof. Dr. Leize
Credits (ECTS): 4 Points
Semester: 4. Semester
Pre-requisites with regard to content: None
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: In the Focal Subjects, the students choose from the available elective subjects. The competencies result from these. It is also possible to choose from the german elective subjects of the EITB course.
Assessment: Results according to the chosen subjects.

Course: Focal Subjects 1
Module code: EEIB411
Lecturer: verschiedene
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Elective subject
Language of instruction: English
Content: The content results from the chosen subjects
Recommended reading: See Module book according to chosen subjects.

2.4.1.1. Elective Subject: Applied Control

Applied Control

Module overview
Module code: NN, (EITB440A, German course)

Module Responsible(s): Prof. Dr. Philipp Nenninger
Module scope (ECTS): 7 points
Classification (semester): 4th semester
Content Requirements: Knowledge of the modules Fundamentals of Computer Science 1, Computer Engineering, Digital Technology.
Prerequisites as per SPO: According to SPO, no formal requirements are necessary.
Competencies: Participants will be able to implement applications on programmable logic controllers by a) Be able to map requirements to switchgear and switching networks b) Know special features of the PLC computer class c) master various IEC61131 programming languages and be able to select a suitable one according to the problem. To be able to design, implement and commission technical systems based on programmable logic controllers.
Examination Credits: The students' theoretical knowledge and their knowledge acquired in the laboratory are assessed in a written exam (duration 120 min). The practical skills are evaluated in the laboratory experiments by colloquia and by written reports on each laboratory experiment.
Usability: In this module, the focus is on the methods of classical control technology (switching networks) and their mapping to the computer type "programmable logic controller (PLC)". The modeling of technical processes in graphical and mathematical form and the cross-system view, on the other hand, are anchored as the main focus in the "Automation Technology" module.

Course: Applied Control
Module Code: NN, (EIT441A, German Course)
Lecturer(s): Prof. Dr. Philipp Nenninger
Scope (SWS): 4
Cycle: Summer semester
Type, mode: lecture, compulsory subject
Teaching language: English
Contents: • System overview: Components of an automation system • Number representations, coding systems • Data formats according to IEC standard • Programming model of the PLC • Design methods for switching networks and switching stations
Recommended reading:

- Seitz, M.: Programmable logic controllers, Fachbuch-verlag Leipzig, 2003
- Wellenreuther; Zastrow: Automatisieren mit SPS, Vieweg 2001, (ISBN 3-528-03910-8)
- Berger, H.: Automation with STEP 7 in IL and SCL, Siemens ed. Publicis Corporate Publishing, (ISBN 3-89578-197-5)
- Braun, W.: Programmable logic controllers in practice, Vieweg, 1999
- Borucki, L.: Digital Technology, Teubner, (ISBN 3-519-36415-8)
- Hertwig, A.; Brück, R.: Entwurf digitaler Systeme, Hanser, (ISBN 3-446-21406-2).

Course: Applied Control Lab
EDP designation: EITB442A
Lecturer(s): Prof. Dr. Philipp Nenninger and lecturers
Scope (SWS): 2
Cycle: Summer semester
Type, mode: laboratory, compulsory subject
Teaching language: English
Contents: Try to: • Design, project planning and programming of control engineering solutions for a process model from manufacturing automation • Testing and commissioning of hardware and software for a sub-process (each participant group for itself) • Integration test and commissioning of the overall process model (all participants together)
Recommended reading: • Seitz, M.: Programmable logic controllers, Fachbuchverlag Leipzig, 2003 • Wellenreuther; Zastrow: Automatisieren mit SPS, Vieweg 2001, (ISBN 3-528-03910-8) • Berger, H.: Automation with STEP 7 in IL and SCL, Siemens ed. Publicis Corporate Publishing, (ISBN 3-89578-197-5) • Braun, W.: Programmable logic controllers in practice, Vieweg, 1999 • Borucki, L.: Digital Technology, Teubner, (ISBN 3-519-36415-8) • Hertwig, A.; Brück, R.: Entwurf digitaler Systeme, Hanser, (ISBN 3-446-21406-2).

2.4.2 Advanced Electronics

Advanced Electronics

Module Summary
Module code: EEIB420
Module coordinator: Prof. Dr. Frieder Keller
Credits (ECTS): 7 Points
Semester: 4. Semester
Pre-requisites with regard to content: Competencies acquired in modules Mathematics 1 + 2 +3, Circuit Analysis 1 + 2, Instrumentation and Measurement, Signals and Systems
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Participants will be able to describe and analyze electronic circuits and to design basic circuits for a given purpose of application by • knowing about properties of semiconductor materials as well as the characteristics of diodes, bipolar- and field effect-transistors • knowing about the behavior of semiconductor devices a part of electronic circuits • representing diodes and transistors by equivalent circuit diagrams • apply small-signal parameters to describe amplifier circuits • partitioning complex circuits in acquainted basic circuits, • designing circuits for a given application by combination of basic circuits to develop an advanced understanding of electronic semiconductor circuits.
Assessment: Exam, 120 minutes for the theoretical aspects. Practical skills are evaluated by colloquia during the lab experiments and a written report for each experiment.
Usability: This module provides the basics of semiconductor based electronic circuits. Aspects of Instrumentation and Measurement are treated in the same-named module.

Course: Advanced Electronics
Module code: EEIB421
Lecturer: Prof. Dr. Michael Bantel, Prof. Dr. Frieder Keller, Prof. Dr. Alfons Klönne, Prof. Dr. Hermann Ng
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject

Language of instruction: English
Content: • Properties of semiconductor materials • Semiconductor diodes • Bipolar transistors (npn and pnp) • Characteristics of bipolar transistors • Ebers-Moll und Gummel-Poon model • Spice-Parameter of bipolar transistors • Transistor used as switches, active and reverse area, saturation • Transistor used as small-signal amplifier, small-signal parameters and calculation of the operating point • Calculation of the frequency response • Miller-theorem • Evaluation of harmonics and distortion • Current sources and current mirrors • JFETs • n-MOS und p-MOS FETs • calculation of the operating points of FETs • FET as small signal amplifier • Basics of integration • CMOS inverters • Parasitic effects in integrated circuits
Recommended reading: • Tietze, Ulrich; Schenk, Christoph: Electronic Circuits, Springer Verlag • Horowitz, Paul; Winfried, Hill: The Art of Electronics. Cambridge University Press • Sedra, Adel, S., Kenneth C. Smith: Microelectronic Circuits, Saunders College Publishing • Gray, Paul R., Robert G. Meyer: Analysis and Design of Analog Integrated Circuits, John Wiley & Sons, Inc. • Soclof, Sidney: Design and Applications of Analog integrated Circuits, Prentice Hall, Eglewood Cliffs • Böhmer, Erwin: Bauelemente der angewandten Elektronik, Vieweg Verlag

Course: Advanced Electronics Lab
Module code: EEIB422
Lecturer: Prof. Dr. Michael Bantel, Prof. Dr. Frieder Keller
Scope of weekly semester hours (SWS): 2
Semester of delivery: Summer semester
Type/mode: Laboratory, Compulsory subject
Language of instruction: English

Experiments: • SPICE simulation of basic circuits treated in the lecture • Measurement of characteristics of a transistor circuit, examination of the operation areas: active and reverse area, saturation • Differential amplifier used in OPAMPs • Amplifier based on bipolar technology • Push-Pull-Amplifier (Class A, Class B, Class A-B modes)
Recommended reading: • Tietze, Ulrich; Schenk, Christoph: Electronic Circuits, Springer Verlag • Horowitz, Paul; Winfried, Hill: The Art of Electronics. Cambridge University Press • Sedra, Adel, S., Kenneth C. Smith: Microelectronic Circuits, Saunders College Publishing • Böhmer, Erwin: Bauelemente der angewandten Elektronik, Vieweg Verlag

2.4.3 Microcontroller Systems

Microcontroller Systems

Module Summary
Module code: EEIB430
Module coordinator: Prof. Dr. Christian Langen
Credits (ECTS): 6 Points
Semester: 4. Semester
Pre-requisites with regard to content: Knowledge and skills learned in lectures and laboratories Computer Programming (EEIB141). Computer Programming Lab (EEIB142). Digital Electronics (EEIB241) and Digital Electronics Lab (EEIB242).
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: Students know specific design and performance characteristics of microcomputer architectures and systems and can evaluate their usability to solve given problems in areas of electrical engineering and information technology. In the module Microcontroller Systems design of embedded systems is learned in combination of hardware and low-level programming skills.
Assessment:

Students' theoretical skills acquired in the lecture Microcontroller Systems are evaluated by a written examination (duration time of 120 minutes). Practical skills in use of the development system and results of laboratory experiments are evaluated with colloquiums to each laboratory experiment.
Usability: The module covers specific requirements on programming of microcontrollers in embedded systems. Feasibility of a microcontroller system is judged in accordance to the requirements (specifications) for a given problem set. Relationships are to the classes Computer Programming (EEIB141) and Computer Programming Lab (EEIB142) where fundamental knowledge of the C/C++ programming language are taught as well as Digital Electronics (EEIB241) and Digital Electronics Lab (EEIB242) that are updated and augmented in associated chapters (computer arithmetic, peripheral interfaces).

Course: Microcontroller Systems
Module code: EEIB431
Lecturer: Prof. Dr. Christian Langen
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture with integrated exercises, Compulsory subject
Language of instruction: English
Content: • Introduction – Embedded Systems • Processor Architectures and Instruction Sets • ARM Assembly Language Programming • The ARM Architecture • ARM-Organization and Implementation • The ARM Instruction Set • Architectural Support for High-Level Languages • Memory Hierarchy, Cache Architectures • Architectural Support for Operating Systems • Real-Time Systems Concepts • Peripheral Interfaces, PWM and Analogue-to-Digital Converters (ADCs)
Recommended reading: • Abbot, Doug: Embedded Linux Development Using Eclipse. Newnes 2009. • Cockerell, Peter: ARM Assembly Language Programming. M.T.C. 1987 • Furber, Steve: ARM System-on-Chip Architecture. Addison-Wesley, 2000 • Gibson, J. R.: ARM Assembly Language – an Introduction (Second Edition). J.R. Gibson 2011 • Hohl, William: ARM Assembly Language. Fundamentals and Techniques. CRC Press 2009. • Labrosse, Jean J.: MicroC/OS-II, CMP Books, Second Edition 2002 • Smith, Warwick A.: C Programming for Embedded Microcontrollers, Elektor 2008

- Sloss, Andrew N.; Symes, Dominic; Wright, Chris: ARM System Developers Guide. Designing and Optimizing System Software. Morgan Kaufman, 2004.
- Van Someren, Alex; Atack, Carol: The ARM RISC Chip. A Programmers Guide, Addison-Wesley, 1994

Course: Microcontroller Systems Lab
Module code: EEIB432
Lecturer: Prof. Dr. Christian Langen
Scope of weekly semester hours (SWS): 2
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Computer Arithmetic • Modular Programming, Usage of Memory Stack • Parallel Input/Output (I/O) by Peripheral Interfaces • Serial Data Communication (RS232) • Low-Level C-Programming, Interrupts, Timers • Configuration of an Analogue-to-Digital Converter (ADC) Real-Time Operating System Application
Recommended reading: • Abbot, Doug: Embedded Linux Development Using Eclipse. Newnes 2009. • Cockerell, Peter: ARM Assembly Language Programming. M.T.C. 1987 • Furber, Steve: ARM System-on-Chip Architecture. Addison-Wesley, 2000 • Gibson, J. R.: ARM Assembly Language – an Introduction (Second Edition). J.R. Gibson 2011 • Hohl, William: ARM Assembly Language. Fundamentals and Techniques. CRC Press 2009. • Labrosse, Jean J.: MicroC/OS-II, CMP Books, Second Edition 2002 • Smith, Warwick A.: C Programming for Embedded Microcontrollers, Elektor 2008 • Sloss, Andrew N.; Symes, Dominic; Wright, Chris: ARM System Developers Guide. Designing and Optimizing System Software. Morgan Kaufman, 2004. • Van Someren, Alex; Atack, Carol: The ARM RISC Chip. A Programmers Guide, Addison-Wesley, 1994.

2.4.4 Control Systems

Control Systems

Module Summary
Module code: EEIB440
Module coordinator: Prof. Dr. Frieder Keller
Credits (ECTS): 7 Points
Semester: 4. Semester
Pre-requisites with regard to content: Competencies acquired in modules Mathematics 1 + 2 +3, Circuit Analysis 1 + 2, Instrumentation and Measurement, Signals and Systems
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: • knowing about properties of semiconductor materials as well as the characteristics of diodes, bipolar- and field effect-transistors • knowing about the behavior of semiconductor devices a part of electronic circuits • representing diodes and transistors by equivalent circuit diagrams, • apply small-signal parameters to describe amplifier circuits, • partitioning complex circuits in acquainted basic circuits, • designing circuits for a given application by combination of basic circuits to develop an advanced understanding of electronic semiconductor circuits. Participants will be able to describe and analyze control loops and to design basic controllers for a given purpose of application by • knowing about basic terms and definitions in control theory • describing system dynamics in time- and frequency-domain • representing systems as block diagrams • modelling systems mathematically and identifying parameters • analyzing control loops regrading dynamics, accuracy and overshoot • designing controllers with commonly used methods • realizing analogue and digital controllers • designing multiloop control systems to have a basic understanding of control engineering, to describe and analyze control systems mathematically, and to design and implement control loops. The associated lab deepens the theoretical knowledge by real-life, hands-on experiments.
Assessment: Exam, 120 minutes for the theoretical aspects. Practical skills are evaluated by colloquia during the lab experiments and a written report for each experiment.
Usability:

This module provides the basics of control theory and the foundation for advanced techniques in control engineering

Course: Control Systems
Module code: EEIB441
Lecturer: Prof. Dr. Frieder Keller
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Introduction: typical tasks and applications in control theory, history, basic terms and definitions, classification of systems, linear operations and modelling in block diagrams and corresponding transformations • LTI-Systems: Modelling in time and frequency domain, basic dynamic functional blocks • Modelling of processes and identification of parameters • Analysis of control loops regarding stability (Nyquist- and Routh-Hurwitz-criterion), accuracy, dynamics and robustness • Classical design methods: compensation, PID-controllers, root locus techniques • Windup phenomenon • Digital implentation of controllers
Recommended reading: • Nise, Norman S.: “Control systems engineering”, John Wiley, 2000. • Ogata, Katsuhiko: “Modern Control Engineering”, Prentice Hall • Tietze, Ulrich; Schenk, Christoph: Electronic Circuits, Springer Verlag • Föllinger, O.: Regelungstechnik: Einführung in die Methoden und ihre Anwendungen, 12. Auflage, VDE Verlag, Offenbach, 2016 • Hoffmann, J.; U. Brunner: MATLAB & Tools für die Simulation dynamischer Systeme, Addison-Wesley, München, 2002 • Mann, H.; H. Schiffelgen; R. Froriep: Einführung in die Regelungstechnik: Analoge und digitale Regelungen, Fuzzy-Regler, Regler-Realisierung, Software, 11. Auflage, Carl Hanser Verlag, München, 2009

Course: Control Systems Lab
Module code: EEIB442
Lecturer: Prof. Dr. Frieder Keller
Scope of weekly semester hours (SWS): 2
Semester of delivery: Summer semester
Type/mode: Labor, Compulsory subject
Language of instruction: English

Content: • Modelling and analysis of LTI-systems with MATLAB/Simulink • Liquid level control • Modelling, simulation and control of DC-servo-system • Digital control of a magnetical levitation system Operation if a ball-on-rim system
Recommended reading: • Nise, Norman S.: “Control systems engineering”, John Wiley, 2000. • Ogata, Katsuhiko: “Modern Control Engineering”, Prentice Hall • Tietze, Ulrich; Schenk, Christoph: Electronic Circuits, Springer Verlag • Föllinger, O.: Regelungstechnik: Einführung in die Methoden und ihre Anwendungen, 12. Auflage, VDE Verlag, Offenbach, 2016 • Hoffmann, J.; U. Brunner: MATLAB & Tools für die Simulation dynamischer Systeme, Addison-Wesley, München, 2002 • Mann, H.; H. Schiffelgen; R. Froriep: Einführung in die Regelungstechnik: Analoge und digitale Regelungen, Fuzzy-Regler, Regler-Realisierung, Software, 11. Auflage, Carl Hanser Verlag, München, 2009

2.4.5 Management

Management

Module Summary
Module code: EEIB450
Module coordinator: Lecturers of the “Studium Generale” offered by the Center of Competence
Credits (ECTS): 6 Points
Semester: 4. Semester
Pre-requisites with regard to content: none
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required.
Competencies: The participants can acquire further qualifications in the area of management and business administration in order to be able to use their personal skills better in professional life. The students • know the principles of human resources management • are able to carry out an analysis of the annual financial statements with the help of suitable key figures;

• are able to use important parameters of corporate management in a controlling manner.
Assessment: The courses are offered by the Center of Competence. The examinations for the individual courses can be found the program booklet at www.h-ka.de/studiumgenerale/profil.

Course: Focal Subjects 1
Module code: EEIB451
Lecturer: NN
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: In the focal Subjects, the students choose from the available elective subjects. The competencies result from these. It is also possible to choose from the german-language elective subjects of the EITB course.
Recommended reading: • See details of specific course

2.5 Semester 5

- Practical Training Guidance
- Practical Training

2.5.1 Practical Training Guidance

Practical Training Guidance

Module Summary
Module code: EEIB510
Module coordinator: Prof. Dr. Harald Sehr
Credits (ECTS): 6 Points
Semester: 5. Semester
Pre-requisites with regard to content: Modules of the first three semesters
Pre-requisites according to the examination regulations: Completed first study period
Competencies: The participants extend their personal, social and methodical competencies with respect to a practical placement in a company or a research institute by • Evaluating their own soft skills competences • Participating in soft skill courses • Taking part in the presentations of their fellow students and giving feedback to the talks • Presenting their own practical placement and obtaining feedback for it This course helps students in their preparation for the practical training term and provides an overview on potential areas of their future work.
Assessment: Practical training preparation: Exercise (1 semester), academic achievement Practical training follow-up: Seminar paper (1 semester) and presentation of 20 minutes, academic achievement

Course: Practice Preparation
Module code: EEIB511
Lecturer: Lecturer for Business Administration
Scope of weekly semester hours (SWS): 2
Semester of delivery: Winter semester
Type/mode: Lecture, participation in presentations of fellow students, compulsory subject (block course)
Language of instruction: English
Content: Within the course practical training preparation the students take part in • an introduction seminar to the practical training term clarifying organisational aspects of the practical placement

• a soft skill course of their own choice • the presentations of their fellow students presenting their practical placement
Recommended reading: • Nagarajan, S. K.; Mohanasundaram, R.: Innovation and Technologies for Soft Skill Development and Learning, IGI Global • Munson, T.: People Skills for Engineers, 2018

2.5.2 Practical Placement

Practical Placement

Module Summary
Module code: EEIB520
Module coordinator: Prof. Dr. Harald Sehr
Credits (ECTS): 24 Points
Semester: 5. Semester
Pre-requisites with regard to content: Modules of the first three semesters
Pre-requisites according to the examination regulations: Completed first study period and at least 22 CPs from third semester
Competencies: In the practical placement students apply their knowledge obtained in the preceding semesters of study. As a member of a team the trainee works on his own project solving tasks in the field of electrical engineering and information technology. Students are able to reflect and analyse their new experiences. They get to know different aspects of decision processes in industry or service enterprises and obtain a profound insight into economical, technical, organisational and social aspects of a company.
Assessment: Practical work / 95 days of attendance, academic achievement
Usability: In the practical placement students apply their knowledge from preceding semesters in practical work.

Course: Practical Placement
Module code: EEIB521
Lecturer: Prof. Dr. Harald Sehr

Scope of weekly semester hours (SWS):
Semester of delivery: Winter semester
Type/mode: Practical placement in a company or institute, duration at least 95 day of attendance
Language of instruction: English
Content: Students carry out their practical training in a suitable company or institute for a duration of at least 95 days of attendance. A contract for the practical training term includes usually six months. The students work on projects in the fields of electrical engineering and information technology applying their knowledge obtained in previous study semesters. An experienced engineer or scientist supervises the trainee. The projects provide insight into economical, technical and organisational aspects of the company and prepare students for their future career. The students are responsible to find a suitable company or institute for their practical placement and sign a contract with the company or institute. The students write a report on their practical training according to the requirements showing that the contents and tasks described have actually been carried out. The report is confirmed and cleared by the company or institute. At the end of the practical training, the student obtains a letter from the company or institute confirming the practical training and its duration.
Remark: The practical training term (5th semester) is completed, when the practical training preparation, the practical training follow-up and the practical placement are completed.

2.6 Semester 6

- Focal Subjects 2
- Digital Systems

2.6.1 Focal Subjects 2

Focal Subjects 2

Module Summary
Module code: EEIB610
Module coordinator: Prof. Dr. Leize
Credits (ECTS): 24 Points
Semester: 6. Semester
Pre-requisites with regard to content: None
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: In the focal Subjects, the students choose from the available elective subjects. The competencies result from these. It is also possible to choose from the german-language elective subjects of the EITB course.
Assessment: Results from the chosen subjects.
Usability:

2.6.1.1. Focal Subjects 2: Automation Engineering

Automation Engineering

Module overview
EDP designation: EITB610A
Module Responsible(s): Prof. Dr. Philipp Nenninger
Module scope (ECTS): 7 points
Classification (semester): 6th semester
Content Requirements: Knowledge of the modules control engineering, control engineering, measurement engineering
Prerequisites as per SPO: According to SPO, no formal requirements are necessary.
Competencies: Participants will be able to translate technical issues into automation solutions by

a) Apply appropriate modeling techniques and develop systems in this way b) Be able to make architectural and communication decisions to be able to design and commission systems that function in practice.
Examination Credits: The students' theoretical knowledge as well as their knowledge acquired in the laboratory will be assessed in a written exam (duration 120 min). The practical application of the skills is evaluated in the laboratory experiments through colloquia and a written report.
Usability: This module focuses on the modeling of technical processes in graphical and mathematical form as well as their program-technical realization. The mapping to concrete automation computers, on the other hand, is anchored as a focal point in the "Control Engineering" module. Although the concepts of control engineering are used for modeling, controller design, stability criteria, etc. are reserved for the "Control Engineering" module.

Course: Automation Engineering
EDP designation: NN, (EIT611A, German course)
Lecturer(s): Prof. Dr. Philipp Nenninger
Scope (SWS): 4
Cycle: Summer semester
Type, mode: lecture, compulsory subject
Teaching language: English
Contents: • Process and process types • Basics of modeling • Graphical models, mathematical models, state-oriented models (Petri nets) • Process coupling, conversion principles, coding • Scaling, standardization, monitoring of process variables • Fieldbus systems, requirements and implementation structures • Reliability, safety and availability • Process operation and monitoring • Design, organization and operation of automation systems
Recommended reading: • Polke, M.: Prozess-Leittechnik, Oldenbourg-Verlag, 1994 • Früh, K. F.: Handbuch Prozessautomatisierung, Oldenbourg, 2000 • Jakoby, W.: Automation Technology - Algorithms and Programs, Springer 1996 • Olsson; Piani: Control, Regulation, Automation, Hanser, 1993 • Bergmann, J.: Automatisierungs- und Prozeßleittechnik, Fachbuch-verlag Leipzig, 1999 • Lauber, R., Göhner, P.: Prozeßautomatisierung Band 1+2, Springer 1999 • Strohrmann, G.: Automatisierung verfahrenstech. Processes, Oldenbourg, 2002 • Lunze, J. : Automatisierungstechnik, Oldenbourg, 2003 • Schuler, H.: Litigation, Oldenbourg, 1999 • Felleisen, M.: Prozessleittechnik für die Vefahrensindustrie, Oldenbourg, 2001

- Langmann, R.: Taschenbuch der Automatisierung, Fachbuchverlag Leipzig, 2004
- Charwat, H.J.: Lexicon of Man-Machine Communication, Oldenbourg, 1994.
- Schnell, G.: Bussysteme in der Automatisierungs- und Prozesstechnik, Vieweg, 2000
- Reißenweber, B.: Fieldbus systems, Oldenbourg, 1998
- Scherff, B., Haese, E., Wenzek, H.R.: Fieldbus systems in practice, Springer, 1999

Course: Automation Engineering Laboratory
EDP designation: NN, (EITB612A, German course)
Lecturer(s): Prof. Dr. Philipp Nenninger
Scope (SWS): 2
Cycle: Summer semester
Type, mode: laboratory, compulsory subject
Teaching language: English
Contents: Try to: • Modeling of technical processes • Scaling, normalization and filtering of process variables • Design and implementation of process control solutions with integrated control and regulation functions • Use of systems for operation and monitoring of processes (SCADA systems) • Communication via various fieldbus systems • Test strategies and test aids for process coupling
Recommended reading: • Seitz, M.: Programmable logic controllers, Fachbuchverlag Leipzig, 2003 • Wellenreuther; Zastrow: Automatisieren mit SPS, Vieweg 2001, (ISBN 3-528-03910-8) • Berger, H.: Automation with STEP 7 in IL and SCL, Siemens ed. Publicis Corporate Publishing, (ISBN 3-89578-197-5) • Braun, W.: Programmable logic controllers in practice, Vieweg, 1999 • Borucki, L.: Digital Technology, Teubner, (ISBN 3-519-36415-8) • Hertwig, A.; Brück, R.: Entwurf digitaler Systeme, Hanser, (ISBN 3-446-21406-2).

2.6.1.2. Focal Subjects 2: Robotics

Robotics

Module overview
EDP designation: NN, (EITB640A, German course)
Module Responsible(s): Prof. Dr. Daniel Braun
Module scope (ECTS): 5 points

Classification (semester): 6th semester
Content Requirements: Computer engineering
Prerequisites as per SPO: According to SPO, no formal requirements are necessary.
Competencies: The participants learn how to work with robots in which they a) Learn the necessary theoretical basics about robotics b) Use coordinate transformations and kinetic modeling for path planning c) Learn about hardware, software and sensor technology for robots d) Apply programming methods and programming languages to be able to process common operations in automation technology with robots.
Examination Credits: The students' theoretical knowledge and their knowledge acquired in the laboratory are assessed in a written exam (duration 90 min). The practical skills are evaluated in the laboratory experiments by colloquia and by written reports on each laboratory experiment.
Usability: Control of robots in automation technology applications, application of coordinate transformations, path planning.

Course: Robotics
EDP designation: NN (EIT641A, German course)
Lecturer(s): Prof. Dr. Daniel Braun
Scope (SWS): 2
Cycle: Summer semester
Type, mode: lecture compulsory subject
Teaching language: English
Contents: • Areas of application for industrial and service robots • Kinematic types • Coordinate transformations • Kinetic modeling of manipulators • Railroad planning • Sensors • Control architecture in hardware and software • Programming methods and programming languages
Recommended reading: • Dillmann, R.; Huck, M.: Information Processing in Robotics, Springer-Verlag Berlin, Heidelberg, 1991. • Hertzberg, J.: Mobile Robots, Springer Vieweg, 2012

Course: Robotics Lab
EDP designation: EITB642A
Lecturer(s): Prof. Dr. Daniel Braun
Scope (SWS): 2
Cycle: Summer semester
Type, mode: laboratory, compulsory subject
Teaching language: English
Contents: Try to: • Basics of robot programming • Teach-in procedure • Programming of complex motion profiles • Implementation of palletizing tasks • Drawing complex geometries • Realization of joining processes
Recommended reading: • Dillmann, R.; Huck, M.: Information Processing in Robotics, Springer-Verlag Berlin, Heidelberg, 1991. • Hertzberg, J.: Mobile Robots, Springer Vieweg, 2012

2.6.1.3. Focal Subjects 2: Wireless Communication and Information Technology

Wireless Communication and Information Technology

Module overview
EDP designation: NN
Module Responsible(s): Prof. Dr. Manfred Litzenburger
Module scope (ECTS): 5 points
Classification (semester): 6th semester
Content Requirements: Signals and Systems, Instrumentation and Measurement, Computer engineering
Prerequisites as per SPO: According to SPO, no formal requirements are necessary.
Competencies:

This subject covers the fundamental principles associated with the methods of information transmission in communication networks with special emphasis on wireless networks.
Students will be able to understand, develop and build current and future information systems and networks by

- Understanding the interaction of the protocol entities in a communications network
- Knowing the functionalities and mechanisms of the used protocols
- Understanding how information is transmitted by radio signals in wireless networks
- Understanding the propagation effects affecting radio signals
- Knowing the special challenges and requirements of mobile communications
- Being able to assess the performance of transmission schemes
- Being able to simulate and analyze transmission systems and network protocols with appropriate tools
- Being aware of the data security threads in open (wireless) networks concerning secrecy, authenticity, and integrity and being able to apply data security measures appropriately

Examination Credits:
The students' theoretical knowledge and their knowledge acquired in the laboratory are assessed in a written exam (duration 90 min). The practical skills are evaluated in the laboratory experiments by colloquia and by written reports on each laboratory experiment.

Usability: Control of industrial information methods and wireless communication strategies.

Course: Wireless Communication and Information Technology

EDP designation: NN

Lecturer(s): Prof. Dr. Manfred Litzenburger

Scope (SWS): 3

Cycle: Summer semester

Type, mode: lecture compulsory subject

Teaching language: English

Contents:

- Communication basics
- Networks and protocols, the OSI-protocol stack
- Climbing up the protocol stack:
    - Layer 1: Physical layer
        - Baseband representation of RF signals
        - (QAM-, PSK-) Modulation, demodulation / detection
        - Wireless communication: frequencies, duplexing, radio propagation, path loss models, channel models (AWGN, multipath channels)
        - Criteria for assessing communication systems: Bit error rate (BER) and bandwidth efficiency
        - Multicarrier modulation (OFDM) (time permitting)
        - Cellular mobile networks, cell planning
    - Layer 2: Data link control

▪ Medium access, multiple access, examples: LTE, Ethernet, WLAN ▪ Error control, Automatic repeat request (ARQ), sliding window protocols ○ Layer 3: Networking ▪ Addressing, routing, Quality-of-Service (QoS) provision, example: IP ○ Layer 4: Transport ▪ Flow control, congestion control, example: TCP • Architecture of the Internet • Cryptography and data security ○ Cyphering (DES, AES, …), authentication, integrity protection ○ Integration of security mechanisms in mobile radio systems (GSM, LTE, WLAN) ○ Transport Layer Security (TLS) ○ Mobile Communication Network
Recommended reading: • See ILIAS

Course: Wireless Communication and Information Technology Lab
EDP designation: NN
Lecturer(s): Prof. Dr. Manfred Litzenburger
Scope (SWS): 1
Cycle: Summer semester
Type, mode: laboratory, compulsory subject
Teaching language: English
Contents: Three lab experiments: • Modelling and simulation (Matlab/Simulink) of digital communication systems (or, alternatively, “real” lab experiment with vector signal generator and vector signal-/ spectrum analyzer) • Network and protocol simulation with ns2 • Protocolanalysis of Internet connections with Wireshark
Recommended reading: • See ILIAS

2.6.1.4. Focal Subjects 2: Physical Sensors

Physical Sensors

Module overview
EDP designation: NN, (EITB450, German course)

Module Responsible(s): Prof. Dr. Harald Sehr
Module scope (ECTS): 5 points
Classification (semester): 4th semester
Content Requirements: Physics, direct current technology, alternating current technology, fields, electronics, measurement technology
Prerequisites as per SPO: According to SPO, no formal requirements are necessary.
Competencies: The participants • can explain functional principles of different physical sensors • can explain and interpret essential basic terms and parameters of various sensors • can independently select a suitable sensor principle based on given requirements • can design and dimension signal processing circuits for sensor systems by • Determine and evaluate sensor parameters, • describe the operating principles of various sensors verbally with the aid of sensor characteristics and by means of formula relationships, • Analyze applications and areas of use of various sensor systems, • Analyze tasks from sensor technology and assign suitable sensor parameters and properties, • set up various sensor systems and their signal conditioning circuits in the laboratory and determine parameters and sensor characteristics by measurement, in order to be able to select or develop sensors for specific requirements in their later careers.
Examination performance: Written exam, 120 minutes
Usability: This module builds on teaching content from the foundation course and the third semester and provides essential core competencies for the sensor and environmental measurement technology fields of study. In addition, the module provides knowledge necessary for understanding more advanced courses, e.g. bio- and chemosensorics.

Course: Physical sensors
EDP designation: NN, (EITB451S, EITB451U, German course)
Lecturer(s): Prof. Dr. Harald Sehr
Scope (SWS): 4
Cycle: Summer semester
Type, mode: lecture, compulsory subject
Teaching language: English
Contents: • Basic concepts of sensor technology

- Properties and characteristics of sensors
- Resistive sensors
- Capacitive sensors
- Inertial sensors
- Thermocouples
- Piezoelectric sensors
- Magnetic field sensors
- Induction sensors
- Inductance sensors
- Eddy current sensors
- Sensor signal conditioning
- Overview of sensor manufacturing technologies

Recommended reading:

- Niebuhr, Lindner: Physical Measurement Technology with Sensors, Oldenburg
- Hering, Schönfelder: Sensors in Science and Technology, Vieweg + Teubner
- Reif, K.: Sensoren im Kraftfahrzeug, Springer Schrüfer, E.: Elektrische Messtechnik, Hanser
- Schiessle, E.: Sensor Technology and Measurement Recording, Vogel
- Schiessle, E.: Industrial Sensor Technology, Vogel
- Hoffmann, J.: Pocketbook of Measurement Technology, Hanser
- Schanz: Sensors - Sensor technology for practitioners, Hüthig

Course: Laboratory Physical Sensors
EDP designation: EITB452S, EITB452U
Lecturer(s): Prof. Dr. Harald Sehr
Scope (SWS): 2
Cycle: winter semester and summer semester
Type, mode: laboratory, compulsory subject
Teaching language: English

Contents:

- Resistive temperature measurement
- Bending beam force sensors with strain gauges
- Capacitive distance measurement
- Differential transformer with carrier frequency amplifier
- Distance and displacement measurement with eddy current sensors
- Vibration analysis with piezoelectric sensors

Recommended reading:

- Niebuhr, Lindner: Phys. measurement technology with sensors, Oldenburg
- Schrüfer, E.: Elektrische Meßtechnik, Hanser

- Hoffmann, J.: Pocketbook of Measurement Technology, Hanser
- Schiessle, E.: Industrial Sensor Technology, Vogel

2.6.2 Digital Systems

Digital Systems

Module Summary
Module code: EEIB620
Module coordinator: Prof. Dr. Strohrmann
Credits (ECTS): 6 Points
Semester: 6. Semester (EITB340A) / 6. Semester (EITB640S)
Pre-requisites with regard to content: Competencies acquired in lectures Mathematics 1 - 3, System Theory, Micro-Controller
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: Students will be able to describe and analyze digital signals and systems in the time, z, and frequency domains by • describing signals in the time domain mathematically as signal sequences • applying the z-transformation to discrete-time signals • reading system properties from impulse responses and transfer functions • determine spectra of energy and power signals • design simple discrete-time filters and • apply the Fast Fourier Transform • to develop an understanding of digital signal processing. • Obtain an overview of different bus systems by • learning principles of signal propagation, signal formatting, and error detection. • covering different bus access methods • applying the ISO/OSI layer model • working out different bus systems in order to be able to select and program suitable interfaces for special applications
Assessment: Exam, 90 minutes and Project.
Differentiation from other modules This module covers the basics of bus systems and digital systems, which are required and deepened in more advanced modules.

Course: Bus Systems

Module code: EEIB621
Lecturer: Prof. Dr. Thorsten Leize
Scope of weekly semester hours (SWS): 2
Semester of delivery: Summer semester
Type/mode: Lecture with integrated excercise, Compulsory subject
Language of instruction: English
Content: • Signal propagation, signal formatting, error detection • Bus access types • ISO/OSI layer model • Different bus systems for different application areas: • Ethernet and TCP/IP family • Field bus systems (serial, HART, Profibus) • Automotive bus systems, especially CAN • I^2C as an example of shortrange bus systems.
Recommended reading: • See Ilias

Course: Digital Systems Theory
Module code: EEIB622
Lecturer: Prof. Dr. Strohrmann
Scope of weekly semester hours (SWS): 4
Semester of delivery: Summer semester
Type/mode: Lecture, Compulsory subject
Language of instruction: English
Content: • Signal sampling and reconstruction • Systems in the time domain, difference equation, system properties, impulse response, convolution, correlation function • Signals and systems in the z-domain, transfer function of discrete-time systems • Spectrum of discrete-time signals, frequency response of discrete-time systems • Fundamentals of the design of digital filters • Fast Fourier Transform
Recommended reading: • Presentations and Media on Ilias learning platform • Oppenheim, Alan: Discrete-Time Signal Processing, Pearson Education Limited, 2013 • Chaparro, Luis: Signals and Systems using MATLAB, Academic Press, 2018

- Lyons, Richard G.: Understanding Digital Signal Processing,
  Pearson India, 2011

2.7 Semester 7

- Focal Subjects 3
- Projects
- Bachelor Thesis
- Final Presentation

2.7.1 Focal Subjects 3

Focal Subjects 3

Module Summary
Module code: EEIB710
Module coordinator: NN.
Credits (ECTS): 8 Points
Semester: 7. Semester
Pre-requisites with regard to content: None
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: In the focal Subjects, the students choose from the available elective subjects. The competencies result from these. It is also possible to choose from the german-language elective subjects of the EITB course.
Assessment: Results from chosen subjects

Course: Focal Subjects 3
Module code: EEIB711
Lecturer:
Scope of weekly semester hours (SWS): 8
Semester of delivery: Winter semester
Type/mode: Lecture, Elective subject
Language of instruction:
Content:
Recommended reading:

2.7.1.1. Focal Subjects 3: Industrial Internet of Things

Industrial Internet of Things

Module overview
EDP designation: EITB710A
Module Responsible(s): Prof. Dr. Philipp Nenninger
Module scope (ECTS): 5 points
Classification (semester): 7th semester
Content Requirements: Control engineering and automation technology; mathematics, fundamentals of electrical engineering, digital signal processing
Prerequisites as per SPO: According to SPO, no formal requirements are necessary.
Competencies: Participants master the basics of a process control system by a) Understand the mapping of continuous production processes into control systems b) Be able to integrate process components in control systems c) Be able to combine process components into a complete system to be able to design and commission complex process automation plants. Participants will be able to process analog signals in digital systems by d) Master the basics of signal sampling and signal processing e) Be able to apply techniques for coupling real-time and non-real-time systems. f) Understand methods for data analysis using artificial intelligence to be able to implement the entire information chain from data acquisition to real-time processing and process data evaluation in real automation systems.
Examination Credits: The students' theoretical knowledge of the lecture Digital Transformation of Automation Technology will be assessed in a written exam (duration 90 min). The students' written reports on the laboratory experiments will be assessed.
Usability: In contrast to the control technology and automation technology modules, the focus here is on the view of holistic management of production processes. Compared to the module Theory of Digital Systems, the algorithms are extended to multidimensional signals.

Course: Industrial Internet of Things
EDP designation: EIT711A
Lecturer(s): Prof. Dr. Philipp Nenninger
Scope (SWS): 2
Cycle: Winter semester
Type, mode: lecture, compulsory subject, block course
Teaching language: English
Contents: • Programming of non-real-time systems (tools, development processes) • Data storage (databases, cloud computing) • Integration of automation systems (MQTT, OPC, OPC UA) • Artificial intelligence methods
Recommended reading: • Mahnke, Leitner, Damm: OPC Unified Architecture • Beaulieu: Learning SQL

Course: Process Control Systems
EDP designation: EIT712A
Lecturer(s): Prof. Dr. Philipp Nenninger
Scope (SWS): 2
Cycle: Winter semester
Type, mode: lecture with integrated laboratory, compulsory subject, block course
Teaching language: English
Contents: Lecture process control engineering • Basics of process control engineering • Manufacturing Execution Systems (MES) and Supervisory Control and Data Acquisition System (SCADA) • Flow processes and recipe operation • Process management • Process control systems In the Process Control Laboratory, students complete experiment to: • Process modeling • Process control systems
Recommended reading: • Früh, Maier, Schaudel: Handbook of Process Automation, Oldenbourg, 2009 • Schuler, Hans: Litigation, Oldenbourg, 2000
Notes: In contrast to automation technology, process control technology deals with a complex multidimensional flow process.

2.7.2 Project

Project

Module Summary
Module code: EEIB720
Module coordinator: Prof. Dr. Manfred Strohrmann
Credits (ECTS): 7 Points
Semester: 7. Semester
Pre-requisites with regard to content: Knowledge of the modules of semesters 1-4
Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required
Competencies: The participants can independently work on a task in small groups and • understand the task and develop the technical implementation in a solution-oriented manner • implement the project with all technical designs and ideally simulate and test it • learn to work together in the team structure • write the documentation as a scientific paper • present the work and discuss questions in order to be able to work out and implement a task in a team systematically and in a targeted manner in professional practice.
Assessment: Written Project documentation
Usability: In contrast to the bachelor thesis, the project work takes place within a group of students and under the guidance of a professor.

Course: Project
Module code: EEIB721
Lecturer: All professors of the faculty
Scope of weekly semester hours (SWS):
Semester of delivery: Winter semester
Type/mode: Project during the semester, implementation at the University
Language of instruction: English
Content:

The content of the project work results from the ongoing research projects and is individually designed differently from semester to semester. The topics result from the course of study. The following tasks are carried out in the team: • Recognize and describe problems • Formulate objectives • Draw time and project plans • Research through literature and expert surveys • Interdisciplinary processing of the task • Formulate and discuss work results in project meetings • Implementation, development and construction of project templates in cooperation with the workshop or development of program parts, solution approaches, etc. • Create a project folder with project documentation • Prepare a technical report • Present the final result in the final presentation and answer questions
Recommended reading: • Hering, L; Hering, H: Technische Berichte, Vieweg, 2003, 4. Auflage

2.7.3 Bachelor Thesis

Bachelor Thesis

Module Summary
Module code: EEIB730
Module coordinator: Prof. Dr. Thorsten Leize
Credits (ECTS): 12 Points
Semester: 7. Semester
Pre-requisites with regard to content: Knowledge of the modules of semesters 1-7
Pre-requisites according to the examination regulations: The project work has to be completed.
Competencies: The students can work on an engineering topic in a given time frame independently, result-oriented and appropriately according to scientific criteria by • analyze and structure information given by literature, independently acquire the relevant specialist and methodological knowledge, • select scientific methods and procedures and use and solve the question of the bachelor thesis, • interpret, evaluate and critically reflect on the results obtained, • formulate the content of the bachelor thesis in a clearly structured manner according to scientific procedures using the specialist terminology

in order to be able to work on topics independently in professional practice and write reports.
Assessment: Written thesis (duration: 4 months)
Usability: In contrast to the practical work in the practical study semester, the Bachelor thesis must be carried out independently.

Course: Bachelor-Thesis
Module code: EEIB731
Lecturer: all faculty members
Scope of weekly semester hours (SWS):
Semester of delivery: Winter semester
Type/mode: Individual project. Duration four month.
Language of instruction: English
Content: Topics from the field of electrical engineering
Recommended reading: • Hering, L; Hering, H: Technische Berichte, Vieweg, 2003, 4. Auflage

2.7.4 Final Presentation

Final Presentation

Module Summary
Module code: EEIB740
Module coordinator: Prof. Dr. Thorsten Leize
Credits (ECTS): 3 Points
Semester: 7. Semester
Pre-requisites with regard to content: Knowledge of the modules of the semesters 1-7
Pre-requisites according to the examination regulations: 189 CP. The Bachelor thesis has to be completed.
Competencies: The participants can independently prepare a presentation and present the questions and the work of the bachelor thesis by • give a short introduction to the topic and present the main questions and tasks

• present the solutions and technical developments • discuss possible solutions and results in order to be able to present, discuss and answer questions in later professional practice.
Assessment: Oral examination (duration: 20 minutes) and presentation (duration: 20 minutes)

Course: Final Presentation
Module code: EEIB741
Lecturer: all faculty members
Scope of weekly semester hours (SWS):
Semester of delivery: Winter semester
Type/mode: repetition of the lecture content, Compulsory subject
Language of instruction: English
Content: Knowledge the basic principles and most important facts from the teaching content of the electrical engineering - information technology course