



Module Handbook Electrical Engineering and Information Technology – EEIB

Degree: Bachelor of Engineering (B Eng.)

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

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|---|------------------------|--|--------------------------------------|--|---|
| 1 | Mathematics 1 6 SWS | Analogue Electronics 1 incl. Project 3 + 1 SWS | Physics incl. Lab 4 + 2 SWS | Programming 1 incl. Lab 2 + 2 SWS | Deutsch als Fremdsprache 1 4 SWS |
| | | | | | Intercultural Communication 2 SWS |
| 2 | Mathematics 2 6 SWS | Analogue Electronics 2 incl. Lab 4 SWS | Electromagnetic Interaction 4 SWS | Digital Electronics incl. Lab 4 + 2 SWS | Deutsch als Fremdsprache 2 4 SWS |
| | | | | | Scientific Work 2 SWS |

Module Summary: Main Study Period

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|---|---|-----------------------------------|--|-----------------------------|--|
| 3 | Mathematics 3 4 SWS | Measurement Technology 4 SWS | Programming 2 incl. Lab 2 + 2 SWS | Systems Theory 4 SWS | Deutsch als Fremdsprache 3 4 SWS |
| | Modelling and Simulation 2 SWS | Measurement Techn. Lab 2 SWS | | | |
| 4 | Focal Subjects 4 SWS | Advanced Electronics 4 SWS | Mikrocontroller- Systems incl. Lab 4 + 2 SWS | Control Theory 4 SWS | Management Focals 4 SWS |
| | | Advanced Electronics Lab 2 SWS | | Control Theory Lab 2 SWS | |
| 6 | Focal Subjects, also from German Language Bachelor's 24 SWS / 30 ECTS-Punkte | | | | Theory of Digital Systems 2 SWS |
| | | | | | Bus Systems 2 SWS |
| 7 | Focal Subjects 8 SWS | Project | Bachelor-Thesis | Final Presentation | |

2 Module

2.1 Semester 1

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

2.1.1 Mathematics 1

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| Mathematics 1 |
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| 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 |
| <p>Competencies:</p> <p>The participants master the elementary basics of engineering mathematics by</p> <ul style="list-style-type: none"> • 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. |
| <p>Usability:</p> <p>This module introduces the foundations for engineering mathematics. The module is the basis for the modules Mathematics 2 and Mathematics 3.</p> |

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| 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 |
| <p>Content:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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

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| Circuit Analysis 1 |
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| 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) <ul style="list-style-type: none"> • 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 <p>And understand how to combine linear parts and sub circuits in order to transfer the knowledge to circuits with more</p> |
| 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. |

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| 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 |

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| <p>Content:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • A. Führer; K. Heidemann; W. Nerreter: Grundgebiete der Elektrotechnik 1: Stationäre Vorgänge, Hanser Verlag, 2012, 9. Auflage • A. Führer; K. Heidemann; W. Nerreter: Grundgebiete der Elektrotechnik 2: Zeitabhängige Vorgänge, Hanser Verlag, 2011, 9. Auflage • Wolff: Grundlagen der Elektrotechnik – Band 1, Das elektrische und das magnetische Feld, Wolff, Aachen 2003, 7. 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 |

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| Course: Circuit Analysis Project 1 |
| Module code: EEIB122 |
| Lecturer: NN |
| Scope of weekly semester hours (SWS): 1 |
| Semester of delivery: Winter semester |
| Type/mode: Exercise, Compulsory subject |
| Language of instruction: English |
| <p>Content:</p> <p>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</p> |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • A. Führer; K. Heidemann; W. Nerreter: Grundgebiete der Elektrotechnik 1: Stationäre Vorgänge, Hanser Verlag, 2012, 9. Auflage • A. Führer; K. Heidemann; W. Nerreter: Grundgebiete der Elektrotechnik 2: Zeitabhängige Vorgänge, Hanser Verlag, 2011, 9. Auflage • Wolff: Grundlagen der Elektrotechnik – Band 1, Das elektrische und das magnetische Feld, Wolff, Aachen 2003, 7. 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 |

Module

- Tietze, U.; Schenk, Ch.; Gamm, E.: Halbleiter-Schaltungstechnik, Springer Verlag, Berlin, 2016, 15.Auflage

2.1.3 Physics

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| Physics |
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| Module Summary |
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| Module code: EEIB130 |
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| Module coordinator: Prof. Dr. Christian Karnutsch |
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| Credits (ECTS): 6 Points |
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| Semester: 1. Semester |
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| Pre-requisites with regard to content: Basic knowledge of Mathematics and Physics |
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| Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required |
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| 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. |
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| 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). |
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| 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. |
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| Course: Physics |
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| Module code: EEIB131 |
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| Lecturer: Prof. Dr. Christian Karnutsch, Prof. Dr. Harald Sehr |
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| Scope of weekly semester hours (SWS): 4 |
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| Semester of delivery: Winter semester |
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| Type/mode: Lecture, Compulsory subject |
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| Language of instruction: English |
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| Content: <ul style="list-style-type: none"> • Geometrical optics |
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| <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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 |

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| 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: Laboratory, Compulsory subject |
| Language of instruction: English |
| <p>Content:</p> <p>Experiments in the following topics:</p> <ul style="list-style-type: none"> • Optical lenses and lens systems • Determination of the electron mass • Vertical falling ball viscometer • Mass moment of inertia and torsional oscillations |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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

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| Programming 1 |
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| 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 |
| <ul style="list-style-type: none"> • 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. |

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

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| Scope of weekly semester hours (SWS): 2 SWS |
| Semester of delivery: Winter semester |
| Type/mode: Lecture, Compulsory subject |
| Language of instruction: English |
| <p>Content:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading/ Development Software</p> <ul style="list-style-type: none"> • See Ilias |

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| 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 |
| <p>Content:</p> <p>The Exercises are done in one of the computer labs.</p> <p>Competencies to achieve are:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading/Development Software:</p> <ul style="list-style-type: none"> • See Ilias |

2.1.5 Language 1

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| Language 1 |
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| 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. |

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| 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. |

Module

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| 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: <ul style="list-style-type: none"> • to be announced |
| Recommended reading: <ul style="list-style-type: none"> • to be announced |

2.2 Semester 2

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

2.2.1 Mathematics 2

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| Mathematics 2 |
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| 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 <ul style="list-style-type: none"> • 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 <p>to be able to apply the mathematical tools in engineering subjects and in practice.</p> |
| Assessment: Exam, 120 minutes |
| Usability: Provide mathematical methods for use in e.g. Electromagnetic Fields, Signals and Systems. |

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| 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/~weth002
- 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

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| Circuit Analysis 2 |
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| 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 |
| <p>Competencies: Participants will be able to describe and analyze Alternating Current (AC) circuits. After having successfully completed the course, they should</p> <ul style="list-style-type: none"> • 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 <p>in order to develop an deepened understanding of electric systems that are widely used in communication and power system engineering.</p> |
| <p>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.</p> |

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| 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 |

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| Type/mode: Lecture, Compulsory subject |
| Language of instruction: English |
| <p>Content:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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 |

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| 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 |
| <p>Laboratory tests to:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • Presentations and Media on Ilias learning platform • Jacob, Michael: Advanced AC Circuits and Electronics: Principles and Applications, Herrick & Jacob Series, 2003 |

Module

- Rawlins, Clay: Basic AC Circuits, Newnes, 2000

2.2.3 Electromagnetic Fields

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| Electromagnetic Fields |
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| 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 <ul style="list-style-type: none"> • 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. |

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| 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

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| Digital Electronics |
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| 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: <ul style="list-style-type: none"> • 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. |

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| 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 exercises, Compulsory subject |
| Language of instruction: English |
| <ul style="list-style-type: none"> • Content: • Number systems |

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| <ul style="list-style-type: none"> • Codes • Boolean Algebra • Karnaugh-Veitch-Diagrams • Basic circuits of digital technology • Calculation circuits • Multiplexer • Digital Circuits • Deraillleurs • Shift register |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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. |

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| 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 |
| <p>Content:</p> <p>Experiments on:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • See lecture. |

2.2.5 Language 2

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| Language 2 |
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| 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. |

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| 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

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| Mathematics 3 |
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| 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 |
| <p>Competencies:</p> <p>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</p> <ul style="list-style-type: none"> • 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 electrostatics. <p>to be able to apply the mathematical tools learned in engineering subjects and in practice.</p> |
| <p>Assessment:</p> <p>Assessment: Exam, 120 minutes; Practical skills in handling simulation tasks are assessed by colloquia.</p> |
| <p>Usability:</p> <p>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.</p> |

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| Course: Mathematics 3 |
| Module code: EEIB311 |

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| 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 |
| <p>Content:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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 |

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| 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 |
| <p>Content:</p> <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • Campbell, Chancelier, Nikoukhah: Modeling and Simulation, in: Scilab/ Scicos with Scicoslab 4.4, Springer Verlag |

2.3.2 Instrumentation and Measurement

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| Instrumentation and Measurement |
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| 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 <ul style="list-style-type: none"> • 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. |

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| 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

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| 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • See corresponding lecture |

2.3.3 Programming 2

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| Programming 2 |
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| 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. |

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| 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 exercise, Compulsory subject |
| Language of instruction: English |
| Content: <ul style="list-style-type: none"> • 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

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| 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: <ul style="list-style-type: none"> • Object oriented software, design and implementation • Exercises to EEIB331 |
| Recommended reading: <ul style="list-style-type: none"> • See Ilias |

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| 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: <ul style="list-style-type: none"> • Small project to be done to the topics of EEIB331 |
| Recommended reading: <ul style="list-style-type: none"> • See EEIB331 und 332 |

2.3.4 Signals and Systems

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| Signals and Systems |
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| 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 <ul style="list-style-type: none"> • 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. |

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| 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 |
| <ul style="list-style-type: none"> • Content: • Signals in the time domain, signal algebra, impulse function, correlation function |

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| <ul style="list-style-type: none"> • 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • Oppenheim, Alan: Signals, Systems and Inference, Pearson, 2017 • Chaparro, Luis: Signals and Systems using MATLAB, Academic Press, 2018 |

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| 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: <ul style="list-style-type: none"> • |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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

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| Language 3 |
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| 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. |

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| 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: <ul style="list-style-type: none"> • 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

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| Focal Subjects 1 |
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| 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. |

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| 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. |

2.4.2 Advanced Electronics

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| Advanced Electronics |
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| 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 <ul style="list-style-type: none"> • 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. |

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| 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 |

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| Language of instruction: English |
| <p>Content:</p> <ul style="list-style-type: none"> • Properties of semiconductor materials • Semiconductor diodes • Bipolar transistors (nnp 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 |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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 |

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| 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 |
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| 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 |

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| Type/mode: Lecture with integrated exercises, Compulsory subject |
| Language of instruction: English |
| <p>Content:</p> <ul style="list-style-type: none"> • 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) |
| <p>Recommended reading:</p> <ul style="list-style-type: none"> • 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 |

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| 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 |
| <p>Content:</p> <ul style="list-style-type: none"> • 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 |
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| Module code: EEIB440 |
| Module coordinator: Prof. Dr. Frieder Keller |
| Credits (ECTS): 7 Points |
| Semester: 4. Semester |
| <p>Pre-requisites with regard to content: Competencies acquired in modules Mathematics 1 + 2 +3, Circuit Analysis 1 + 2, Instrumentation and Measurement, Signals and Systems</p> |
| <p>Pre-requisites according to the examination regulations: Regarding to the examination regulations no pre-requisites are required</p> |
| <p>Competencies:</p> <ul style="list-style-type: none"> • 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 <p>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</p> <ul style="list-style-type: none"> • 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 regarding dynamics, accuracy and overshoot • designing controllers with commonly used methods • realizing analogue and digital controllers • designing multiloop control systems <p>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.</p> |
| <p>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.</p> |
| Usability: |

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

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| 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: <ul style="list-style-type: none"> • 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 implementation of controllers |
| Recommended reading: <ul style="list-style-type: none"> • 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 |

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| 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

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| Management |
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| Module Summary |
| Module code: EEIB450 |
| Module coordinator: Lecturers of the “Studium Generale” offered by the Center of Competence |
| 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: 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 <ul style="list-style-type: none"> • 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 . |

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| 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: |

Module

- See details of specific course

2.5 Semester 5

- [Practical Training Guidance](#)
- [Practical Training](#)

2.5.1 Practical Training Guidance

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| Practical Training Guidance |
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| 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 <ul style="list-style-type: none"> • 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 |

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| 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 <ul style="list-style-type: none"> • an introduction seminar to the practical training term clarifying organisational aspects of the practical placement |

Module

- 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

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| Practical Placement |
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| 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. |

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| 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 |
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| 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: |

2.6.2 Digital Systems

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| Digital Systems |
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| 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 <ul style="list-style-type: none"> • 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 <p>in order to be able to select and program suitable interfaces for special applications</p> |
| 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. |

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| Course: Bus Systems |
| Module code: EEIB621 |
| Lecturer: Prof. Dr. Thorsten Leize |
| Scope of weekly semester hours (SWS): 2 |

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| Semester of delivery: Summer semester |
| Type/mode: Lecture with integrated exercise, Compulsory subject |
| Language of instruction: English |
| Content: <ul style="list-style-type: none"> • 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 • I²C as an example of shortrange bus systems. |
| Recommended reading: <ul style="list-style-type: none"> • See Ilias |

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| 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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

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| Focal Subjects 3 |
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| 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 |

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| 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: <ul style="list-style-type: none"> • |
| Recommended reading: <ul style="list-style-type: none"> • |

2.7.2 Project

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| Project |
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| 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 <ul style="list-style-type: none"> • 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 <p>in order to be able to work out and implement a task in a team systematically and in a targeted manner in professional practice.</p> |
| 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. |

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| 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

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| Bachelor Thesis |
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| 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 <ul style="list-style-type: none"> • 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. |

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| 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: |

Module

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| Topics from the field of electrical engineering |
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| Recommended reading: |
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| <ul style="list-style-type: none"> • Hering, L; Hering, H: Technische Berichte, Vieweg, 2003, 4. Auflage |
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2.7.4 Final Presentation

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| Final Presentation |
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| 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 <ul style="list-style-type: none"> • 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) |

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| 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 |