# Bachelor Program Business Administration with Electrical Engineering and Information Technology (PO 2020)

**Module manual**
Date: 01.09.2021

TECHNISCHE UNIVERSITÄT DARMSTADT

Department of Electrical Engineering and Information Technology

Module manual: Bachelor Program Business Administration with Electrical Engineering andInformation Technology (PO 202

Date: 01.09.2021

Department of Electrical Engineering and Information Technology
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# Contents

# 1 Fundamentals

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Electrical Engineering and Information Technology I | | | | | |
| **Module Nr.**<br>18-hs-1070 | **Credit Points**<br>7 CP | **Workload**<br>210 h | **Self study**<br>135 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Jutta Hanson | | |

| | |
|---|---|
| 1 | **Content**<br>Units and Equations: Unit systems, equation writing.<br>Basic definitions: Charge, current, voltage, resistance, energy and power.<br>Currents and voltages in electrical circuits: Ohmic law, node and mesh equations, parallel and series connections, current and voltage measurement, linear and nonlinear elements, superposition method, star-delta-transformation, node and mesh analysis in linear circuits, controlled sources.<br>AC systems: Time-dependent currents and voltages, steady-state mode sinusoidal currents and voltages in linear RLC-circuits, phasor diagrams, resonances in RLC circuits, AC power, locus diagrams, two-port networks, transformer, polyphase systems. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will be able after visiting this lecture<br>* to utilize the basic equations in electrical engineering,<br>* to determine the currents and voltages in linear and nonlinear circuits,<br>* to analyze DC and AC systems,<br>* to calculate simple filter and resonant circuits,<br>* to apply the complex calculation in electrical AC systems. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc. ETiT, BSc iST, BSc MEC, BSc. Wi-ETiT, BSc CE, LA Physik/Mathematik |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Frohne, H. u.a. Moeller Grundlagen der Elektrotechnik<br>Clausert, H. u.a. Grundgebiete der Elektrotechnik 1 + 2 |
| **Courses** | |

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|---|---|---|---|---|
| | **Course Nr.**<br>18-hs-1070-vl | **Course name**<br>Electrical Engineering and Information Technology I | | |
| | **Instructor**<br>Prof. Dr.-Ing. Jutta Hanson | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-hs-1070-ue | **Course name**<br>Electrical Engineering and Information Technology I | | |
| | **Instructor**<br>Prof. Dr.-Ing. Jutta Hanson | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Electrical Engineering and Information Technology II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-gt-1020 | **Credit Points**<br>7 CP | **Workload**<br>210 h | **Self study**<br>135 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Gerd Griepentrog | | |

| | |
|---|---|
| 1 | **Content**<br>Electrostatic fields; stationary electrical flow fields; stationary magnetic fields; temporally variable magnetic fields; capacitor networks, transmission lines |
| 2 | **Learning objectives / Learning Outcomes**<br>The students have detached themselves from the conception that all electrical procedures are line- bound; they have a clear idea of the field term, can read and interpret field plots and also design simple field plots themselves; they understand the difference between a curl and a divergence field, can describe this difference mathematically and are able to recognize the field type from a mathematical description, respectively; they are able to calculate field distributions for simple rotationally symmetric arrangements analytically; they can deal surely with the definitions of the electrostatic, the electrical quasi-static, the magnetostatic and the magneto-electric field; they have recognized the connection and dualism of electricity and magnetism; they control the mathematical apparatus necessary for their description and can apply it to simple examples; they can calculate with nonlinear magnetic circuits; they can compute inductance, capacity and resistance of simple geometrical arrangements and understand them now as physical characteristics of the respective arrangement; they have recognized, how different forms of energy can be transferred into each other and are thereby already able to solve simple scientific engineering problems; they have understood the underlying physical backgrounds for many applications of electrical engineering and are able to describe them mathematically, develop it further in a simple way and apply it to other examples; they are familiar with the system of Maxwell's equations and can transfer them from the integral into the differential form; they have a first idea of the importance of Maxwell's equations for all conceptual formulations of electrical engineering and they understand the propagation of electromagnetic waves in the free space and on transmission lines |
| 3 | **Recommended prerequisite for participation**<br>Electrical Engineering and Information Technology I |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)**<br>Notenverbesserung entsprechend §25 (2) APB TU Darmstadt |
| 8 | **References**<br>• Downloadable slides<br>• Clausert, Wiesemann, Hinrichsen, Stenzel: „Grundgebiete der Elektrotechnik I und II"; ISBN 978-3-486-59719-6<br>• Prechtl, A.: „Vorlesungen über die Grundlagen der Elektrotechnik – Band 2" ISBN: 978-3-211-72455-2 |
| **Courses** | |

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|---|---|---|---|---|
| | **Course Nr.**<br>18-gt-1020-vl | **Course name**<br>Electrical Engineering and Information Technology II | | |
| | **Instructor**<br>Prof. Dr.-Ing. Gerd Griepentrog | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-gt-1020-ue | **Course name**<br>Electrical Engineering and Information Technology II | | |
| | **Instructor**<br>Prof. Dr.-Ing. Gerd Griepentrog, M.Sc. Daniel Großmann | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Deterministic Signals and Systems | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kl-1010 | **Credit Points**<br>7 CP | **Workload**<br>210 h | **Self study**<br>135 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

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|---|---|
| 1 | **Content**<br>Fourier Series: Motivation; Fourier series with real coefficients; Fourier series with complex coefficients;examples and applications<br>Fourier Transform: Motivation - Derviation from Fourier series - Dirichlet conditions - delta function - step function - properties of F-transform - special cases - examples and applications - transmissions systems-expansion into partial fractions<br>Convolution: Time invariant systems - convolution in frequency domain- Parseval's theorem - properties-examples and applications<br>Systems and Signals: Bandlimited and time limited systems - systems with only one energy store - examples and applications<br>Laplace Transform: Motivation - single sided L-transform - inverse L-transform - theorems of L- transform - examples and applications<br>Linear differential equations: Time invariant systems - rules - general differentiation - linear passive electrical networks - equivalent circuits for passive electrical elements - examples and applications<br>z-Transform: motivation - sampling - numerical order - definition - examples - transfer function - sampling theorem - examples and applications<br>Discrete Fourier Transform: motivation, derivation sampling, examples and applications |
| 2 | **Learning objectives / Learning Outcomes**<br>The student should understand the principles of integral transformations. He should apply them for the solution of physical problems. The techniques of this lecture are essential tools which will be needed in many follow-up lectures and exercises. |
| 3 | **Recommended prerequisite for participation**<br>Elektrotechnik und Informationstechnik I und Elektrotechnik und Informationstechnik II |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

A script of the lecture or slides respectively, will be provided in electronic form.
Basic Literature:
Wolfgang Preuss, “Funktionaltransformationen”, Carl Hanser Verlag, 2002; Klaus-Eberhard Krueger "Transformationen", Vieweg Verlag, 2002;
H. Clausert, G. Wiesemann "Grundgebiete der Elektrotechnik 2", Oldenbourg, 1993; Otto Föllinger "Laplace-, Fourier- und z-Transformation", Hüthig, 2003;
T. Frey, M. Bossert, Signal- und Systemtheorie, Teubner Verlag, 2004
Further Literature:
Dieter Mueller-Wichards "Transformationen und Signale", Teubner Verlag, 1999
Exercises:
Hwei Hsu "Signals and Systems", Schaum’s Outlines, 1995

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-kl-1010-vl | Deterministic Signals and Systems | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento | | Lecture | 3 |

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-kl-1010-ue | Deterministic Signals and Systems | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento | | Practice | 2 |

| **Module name**<br>Electrical Engineering and Information Technology Lab I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kn-1040 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>60 h | **Duration**<br>2 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Mario Kupnik | | |

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|---|---|
| 1 | **Content**<br>After a safety instruction for electrical equipment, students dolab experiments covering foundations of electrical engineering by using theoretical and experimental instructions to improve basic electrical understanding. Building up a test set autonomously and performing of measurements and evaluations in the form of logs to confirm the theoretical knowledge and lead to independent work in practice.<br>The following experiments are performed:<br>• Investigate real behavior of ohmic resistors<br>• Investigate real behavior of capacitors and inductors<br>• Calculate impedances of basic two-terminal circuits using network theory<br>• Measure of electrical power in AC circuits and investigate in the real behaviour of transformers<br>• DC technology, capacity and inductors, AC technology - Impedances and two-terminal circuits, transformer & power; |
| 2 | **Learning objectives / Learning Outcomes**<br>After preparing the afternoons independently and self-implementing the measurement setup and measurement tasks by active participation in the practical group and by thorough preparation of the associated measurement protocols, you should be able to:<br>• Perform the measurement of basic electrical parameters of DC and AC circuits, independently and in compliance with safety rules<br>• measuring the frequency response of passive electrical networks and resonant circuits, and electric power measurement<br>• the measurement of circuits for the determination of magnetic, electro-thermal and high-frequency. You have to be able to build and run your own measurements<br>• interpretations of the measurement results in terms of its technical meaning, but also their accuracy and error sources safely. |
| 3 | **Recommended prerequisite for participation**<br>Parallel attending the lectures and exercises, “Electrical Engineering I and II” |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>detailed script with instructions for the experiments; Clausert, H. / Wiesemann, G.: Grundgebiete der Elektrotechnik, Oldenbourg,1999 |
| **Courses** | |

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|---|---|---|---|---|
| | **Course Nr.**<br>18-kn-1040-pr | **Course name**<br>Electrical Engineering and Information Technology Lab I A | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Internship | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1041-pr | **Course name**<br>Electrical Engineering and Information Technology Lab I B | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Internship | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1040-tt | **Course name**<br>Electrical Engineering and Information Technology I, Safety instructions and rules | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Tutorial | **SWS**<br>0 |

# 2 Elective Courses

| **Module name**<br>Electronics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1010 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Semiconductor Devices: Diode, MOSFET, Bipolar Transistor; Design of Electronic Circuits;<br>Analog Circuits: Basic Properties, Properties and Application of Operational Amplifiers, Circuit Simulation with SPICE, Small Signal Gain, Single Stage Amplifiers; Frequency Response;<br>Digital Circuits: CMOS Logic Circuits |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to<br>• analyse Diodes, MOS- und Bipolartransistors in simple circuits<br>• calculate the properties of single transistor circuits, such as small signal gain, input and output resistance<br>• design inverting and non-inverting amplifiers from operational amplifiers and knows their ideal and non-ideal properties<br>• calculate the frequency behavior of simple transistor circuits<br>• distinguish the different methods to construct a logical gate from basic transistors and explain their fundamental properties. |
| 3 | **Recommended prerequisite for participation**<br>Basics of Electrical Engineering |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT,BSc iST, BEd |
| 7 | **Grade bonus compliant to §25 (2)**<br>A grade improvement of up to 1,0 due to a bonus is possible, which can be earned with tests. |
| 8 | **References**<br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| **Course Nr.**<br>18-ho-1011-vl | **Course name**<br>Electronics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | **Type**<br>Lecture | **SWS**<br>2 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-ho-1011-ue | Electronics | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | Practice | 1 |

| **Module name**<br>Physics I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1024 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0054-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0054-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Software Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

**1 Content**

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**2 Learning objectives / Learning Outcomes**

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**3 Recommended prerequisite for participation**

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/sp/

**Courses**

| **Course Nr.**<br>18-st-1020-pr | **Course name**<br>Software Lab | |
|---|---|---|
| **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | **Type**<br>Internship | **SWS**<br>3 |

# 3 Electrical Engineering and Information Technology - Options

## 3.1 Option Automation Systems (AUT)

### 3.1.1 AUT - Fundamentals

| | | | | | | |
|---|---|---|---|---|---|---|
| **Module name**<br>System Dynamics and Automatic Control Systems I | | | | | | |
| **Module Nr.**<br>18-ko-1010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>WiSe | |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Ulrich Konigorski | | | |
| 1 | **Content**<br>Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization | | | | | |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems. | | | | | |
| 3 | **Recommended prerequisite for participation** | | | | | |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) | | | | | |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) | | | | | |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, MSc Informatik | | | | | |
| 7 | **Grade bonus compliant to §25 (2)** | | | | | |
| 8 | **References** | | | | | |

| | |
|---|---|
| | Skript Konigorski: “Systemdynamik und Regelungstechnik I”, Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen", Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen", Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation", Jörgl: "Repetitorium Regelungstechnik", Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden", Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise", Schneider: "Regelungstechnik für Maschinenbauer", Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage" |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-ko-1010-vl | **Course name**<br>System Dynamics and Automatic Control Systems I | | |
| **Instructor**<br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-ko-1010-tt | **Course name**<br>System Dynamics and Automatic Control Systems I- Auditorium Exercise | | |
| **Instructor**<br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand | | **Type**<br>Tutorial | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Technical Mechanics for Electrical Engineering | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 16-26-6400 | 6 CP | 180 h | 105 h | 1 | Every 2. Sem. |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Tobias Melz | | |

| | |
|---|---|
| 1 | **Content**<br>Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.<br>Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.<br>Kinematics: point and rigid body movement.<br>Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact. |
| 2 | **Learning objectives / Learning Outcomes**<br>In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module** |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4<br>Exercises are embodied in the book.<br>Further reading:<br>Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6<br>Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2<br>Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1<br>Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).<br>Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.** | **Course name** | | |
| 16-26-6400-vl | Technical Mechanics for Electrical Engineering | | |
| **Instructor** | | **Type** | **SWS** |
| | | Lecture | 3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 16-26-6400-ue | Technical Mechanics for Electrical Engineering | | |
| | **Instructor** | | **Type** | **SWS** |
| | | | Practice | 2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| System Dynamics and Automatic Control Systems II | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ad-1010 | 7 CP | 210 h | 135 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Jürgen Adamy | | |

**1 Content**

Main topics covered are:

- Root locus method (construction and application),
- State space representation of linear systems (representation, time solution, controllability, observability, observer- based controller design)

**2 Learning objectives / Learning Outcomes**

After attending the lecture, a student is capable of:

- constructing and evaluating the root locus of given systems
- describing the concept and importance of the state space for linear systems
- defining controllability and observability for linear systems and being able to test given systems with respect to these properties
- stating controller design methods using the state space, and applying them to given systems
- applying the method of linearization to non-linear systems with respect to a given operating point

**3 Recommended prerequisite for participation**

System Dynamics and Control Systems I

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

**7 Grade bonus compliant to §25 (2)**

**8 References**

Adamy: Systemdynamik und Regelungstechnik II, Shaker Verlag (available for purchase at the FG office)

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ad-1010-vl | System Dynamics and Automatic Control Systems II | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Jürgen Adamy | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-ad-1010-ue | System Dynamics and Automatic Control Systems II | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Jürgen Adamy | | Practice | 2 |

| **Module name**<br>Laboratory Control Engineering I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ko-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Ulrich Konigorski | | |

**1 Content**

- Control of a 2-tank system.
- Control of pneumatic and hydraulic servo-drives.
- Control of a 3 mass oscillator.
- Position control of a MagLev system.
- Control of a discrete transport process with electro-pneumatic components.
- Microcontroller-based control of an electrically driven throttle valve.
- Identification of a 3 mass oscillator.
- Process control using PLC.

**2 Learning objectives / Learning Outcomes**

After this lab tutorial the students will be able to practically apply the modelling and design techniques for different dynamic systems presented in the lecture ”System dynamics and control systems I” to real lab experiments and to bring them into operation at the lap setup.

**3 Recommended prerequisite for participation**

System Dynamics and Control Systems I

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

Lab handouts will be given to students

**Courses**

| **Course Nr.**<br>18-ko-1020-pr | **Course name**<br>Laboratory Control Engineering I | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Ulrich Konigorski | | **Type**<br>Internship | **SWS**<br>4 |

### 3.1.2 AUT - More Fundamentals

| **Module name**<br>General Computer Science II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0290 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Karsten Weihe | | |

| | |
|---|---|
| 1 | **Content**<br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time |
| 3 | **Recommended prerequisite for participation**<br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module** |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

| | |
|---|---|
| | Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009<br>ISBN-13: 978-3-8689-4001-5<br>Algorithmen in Java<br>Robert Sedgewick<br>Pearson Studium<br>3. überarbeitete Auflage, 2003<br>ISBN-13: 978-3-8273-7072-3<br>Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011<br>ISBN-13: 978-3-8689-4076-3 |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>20-00-0290-iv | **Course name**<br>General Computer Science II | | |
| **Instructor** | | **Type**<br>Integrated Course | **SWS**<br>4 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Analog Integrated Circuit Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1020 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog propierties of digital logic gates |
| 3 | **Recommended prerequisite for participation**<br>Lecture “Electronics” |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-ho-1020-vl | **Course name**<br>Analog Integrated Circuit Design | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-ho-1020-ue | **Course name**<br>Analog Integrated Circuit Design | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Electronics | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1010 | 4 CP | 120 h | 75 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

**1 Content**

Semiconductor Devices: Diode, MOSFET, Bipolar Transistor; Design of Electronic Circuits;
Analog Circuits: Basic Properties, Properties and Application of Operational Amplifiers, Circuit Simulation with SPICE, Small Signal Gain, Single Stage Amplifiers; Frequency Response;
Digital Circuits: CMOS Logic Circuits

**2 Learning objectives / Learning Outcomes**

A student is, after successful completion of this module, able to

- analyse Diodes, MOS- und Bipolartransistors in simple circuits
- calculate the properties of single transistor circuits, such as small signal gain, input and output resistance
- design inverting and non-inverting amplifiers from operational amplifiers and knows their ideal and non-ideal properties
- calculate the frequency behavior of simple transistor circuits
- distinguish the different methods to construct a logical gate from basic transistors and explain their fundamental properties.

**3 Recommended prerequisite for participation**

Basics of Electrical Engineering

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT,BSc iST, BEd

**7 Grade bonus compliant to §25 (2)**

A grade improvement of up to 1,0 due to a bonus is possible, which can be earned with tests.

**8 References**

Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ho-1011-vl | Electronics | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | Lecture | 2 |
| **Course Nr.** | **Course name** | | |
| 18-ho-1011-ue | Electronics | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | Practice | 1 |

| **Module name**<br>Electrical Power Engineering | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-bi-1010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

**1 Content**

The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.

First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.

Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.

The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.

**2 Learning objectives / Learning Outcomes**

Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.

They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.

They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.

They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.

**3 Recommended prerequisite for participation**

Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

| | |
|---|---|
| 6 | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE |
| 7 | **Grade bonus compliant to §25 (2)**<br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades. |
| 8 | **References**<br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Renningen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.;Quaschning: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-bi-1010-vl | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-bi-1010-ue | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Introduction to Electrodynamics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-dg-1010 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Herbert De Gersem | | |

| | |
|---|---|
| 1 | **Content**<br>Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi conductor transmission lines (capacitance, inductance, and conductance matrix), velocity definitions, basics of rectangular waveguides. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space. They are able to recognice and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools. |
| 3 | **Recommended prerequisite for participation**<br>Lecture notes. Further literature recommendations are given in the course. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)**<br>Improvement by up to 0.4 due to bonus points which can be acquired by means of e-learning online tests. |
| 8 | **References**<br>Lecture notes. Further literature recommendations are given in the course. |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-dg-1010-vl | **Course name**<br>Introduction to Electrodynamics | | |
| | **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-dg-1010-ue | **Course name**<br>Introduction to Electrodynamics | | |
| | **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Fundamentals of Signal Processing | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-zo-1030 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Abdelhak Zoubir | | |

**1 Content**

The course covers the following topics:

- The basic concepts of stochastic
- The sampling theorem
- Discrete-time noise processes and their properties
- Description of noise processes in the frequency domain
- Linear time-invariant systems: FIR and IIR filters
- Filtering of noise processes: AR, MA, and ARMA models
- The Matched filter
- The Wiener filter
- Properties of estimators
- The method of least squares

**2 Learning objectives / Learning Outcomes**

The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)

In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase.

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc MEC

**7 Grade bonus compliant to §25 (2)**

**8 References**

Lecture notes and slides can be downloaded here:

- http://www.spg.tu-darmstadt.de
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River,1999.

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-vl | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Lecture | 3 |

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-ue | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Practice | 1 |

| **Module name**<br>Microelectronic Devices | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pr-1030 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Sascha Preu | | |

**1 Content**

- Introduction: Semiconductor Devices & Microelectronic
- Semiconductor: Materials, Physics & Technology
- PN-Junction
- Metal-Oxide-Semiconductor Capacity
- Schottky Contact
- MOS-Field-Effect-Transistor (MOSFET)
- CMOS: Digital Applications
- MOS-Memory
- Bipolar- Junction-Transistor
- Outlook: Scaling Limits & SET,...

**2 Learning objectives / Learning Outcomes**

- Understand the physical properties and processes in semiconductor devices and materials
- the operation of basic semiconductor devices like diode, MOS-Transistor and bipolar transistor
- Understand functionality of basic circuits like rectifier circuit , 1-transistor amplifier and inverter from the device point of view.
- Goal: Understand state-of-the art semiconductor devices and circuits as a basis for a successful engineering career

**3 Recommended prerequisite for participation**

Electrical Engineering and Information Technology I, Electrical Engineering and Information Technology II, Laboratory ETiT, Laboratory Electronics, Mathematics I, Mathematics II, Physics

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

Skript: Microelectronic devices - the Basics

- Robert F. Pierret: Semiconductor Device Fundamentals, ISBN 0201543931
- Roger T. How, Charles G. Sodini: Microelectronics - an Integrated Approach, ISBN 0135885183
- Richard C. Jaeger: Microelectronic Circuit Design, ISBN 0071143866
- Y. Taur, T.H. Ning, Fundamentals of Modern VLSI Devices, ISBN 0521559596
- Thomas Tille, Doris Schmidt-Landsiedel: Mikroelektronik, ISBN 3540204229
- Michael Reisch: Halbleiter-Bauelemente, ISBN 3540213848

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-pr-1030-vl | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-pr-1030-ue | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Communication Technology I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kl-1020 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

**1 Content**

Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access

**2 Learning objectives / Learning Outcomes**

After completion of the lecture, students possess the ability to:

- classify signals and communication systems,
- understand, model and analyse basic components of communication systems,
- understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,
- model and analyse base-band commnication systems,
- describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,
- understand, model, evaluate, compare and apply linear modulation schemes,
- design receiver structures for different modulation schemes,
- detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,
- understand and model OFDM,
- understand and model CDMA,
- understand and compare the basic properties of multiple access schemes.

**3 Recommended prerequisite for participation**

Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC

**7 Grade bonus compliant to §25 (2)**

**8 References**

Will be announced in the lecture

**Courses**

| **Course Nr.**<br>18-kl-1020-vl | **Course name**<br>Communication Technology I | |
|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Anja Klein | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-kl-1020-ue | Communication Technology I | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Logic Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Boolean algebra, logic gates, hardware description languages, flipflops, sequential circuits, state-diagrams and -tables, technology mapping, programmable logic circuits |
| 2 | **Learning objectives / Learning Outcomes**<br>By this module, Students will be enabled to<br>• rewrite boolean expressions and transform them into circuits of logic gates<br>• analyze and synthesize digital circuits<br>• describe digital circuits in a hardware description language<br>• extract finite state machines from informal descriptions and implement them with synchronous circuits |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>R.H. Katz: Contemporary Logic Design |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-hb-1010-vl | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-hb-1010-ue | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Measuring Technique | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kn-1011 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Mario Kupnik | | |

**1 Content**

The module includes theoretical discussion and practical application of the measuring chain in detail on example the electrical variables (current, voltage, impedance, power) and selected non-electrical variables (frequency, time, force, pressure and acceleration).
In the lecture the following chapter will be thematically treated measuring signals and measuring equipment (oscilloscope, laboratory testing equipment), static measurement error and disturbance variables (especially temperature), basic measurement circuits, AD conversion principles and filtering, measurement method non-electrical variables and the statistics of measurements (distributions, statist safe tests).
The topics of the lecture are discussed in the exercise of the module. Examples are analyzed and their application in measurement scenarios are practiced.
The practicum of the module consists of five experiments which are time closely matched in time to the lecture:

- Measuring of signals in the time range with digital storage oscilloscope, trigger conditions
- Measuring of signals in the frequency range with digital storage oscilloscope, error of measurement (aliasing / subsampling, leackage) and window functions
- Measuring of mechanical dimensions with suitable primary sensors, sensor electronics / amplifier circuits
- computer-based measuring
- Importing of sensor signals, whose processing and the resulting automated control of a process using a programmable logic controller (PLC)

**2 Learning objectives / Learning Outcomes**

The students know the structure of the measuring chain and the specific properties of the corresponding elements. They know the structure of electronic measuring instruments and basic measuring circuits for electrical and selected non-electrical variables and can apply them. They know the basics of capturing, processing, transferring and storage of measurement data and can describe error sources and quantifying their influences.
In the practicum, the students deepen the basis of the measurements with the oscilloscope, the understanding of the relationship between time and frequency range. Methodically they are able to document and evaluate the data during laboratory measuring.

**3 Recommended prerequisite for participation**

Basics of ETiT I-III, Math I-III, Electronic

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Standard BWS)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 4)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Weighting: 2)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc MEC

| | | | | |
|---|---|---|---|---|
| 7 | **Grade bonus compliant to §25 (2)** | | | |
| 8 | **References**<br>• Slide set of lecture<br>• Textbook and exercise book Lerch: „Elektrische Messtechnik“, Springer<br>• Exercise documents<br>• Practical experiment manuals | | | |
| **Courses** | | | | |
| | **Course Nr.**<br>18-kn-1011-vl | **Course name**<br>Measuring Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1011-pr | **Course name**<br>Measuring Technique Lab | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Internship | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1011-ue | **Course name**<br>Measuring Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Fundamentals of Communication | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-jk-1010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| 1 | **Content**<br>Part 1: Chap. 1 will be a brief introduction in "Electrical Information- and Communication Engineering", presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.<br>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.<br>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.<br>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited inter-symbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture. |
| 2 | **Learning objectives / Learning Outcomes**<br>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.<br>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems. |
| 3 | **Recommended prerequisite for participation**<br>Deterministic Signals and Systems |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |

| | |
|---|---|
| 8 | **References**<br>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addision-Wesley 1992. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-jk-1010-vl | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-jk-1010-ue | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1024 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0054-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0054-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1025 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

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|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0055-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0055-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Software Engineering - Introduction | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

**1 Content**

The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engi-neering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of soft-ware architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).
During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.

**2 Learning objectives / Learning Outcomes**

This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.
After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.

**3 Recommended prerequisite for participation**

sound knowledge of an object-oriented programming language (preferably Java)

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc iST, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/se-i-v/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-su-1010-vl | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-su-1010-ue | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche | | Practice | 1 |

### 3.1.3.1 AUT - Lectures (open catalogue)

| **Module name**<br>Digital Control Systems I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ko-2020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Ulrich Konigorski | | |

| | |
|---|---|
| 1 | **Content**<br>Theoretical fundamentals of sampled control systems:<br>Discrete-time functions, sample/hold element, z-transform, convolution sum, z-transfer function, stability of sampled systems, design of digital controllers, discrete PI-, PD-, and PID-controllers, compensation and dead-beat controller, anti-windup methods |
| 2 | **Learning objectives / Learning Outcomes**<br>The students know the fundamental analysis and design methods for digital feed-forward and feed-back control systems. They know the fundamental differences between continuous-time and discrete-time control systems and can design and analyze discrete-time control systems using different methods. |
| 3 | **Recommended prerequisite for participation**<br>Helpful is knowledge of the Laplace- and Fourier-transforms as well as continuous-time control systems. These fundamentals are taught in the lecture “System Dynamics and Control Systems I” |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc/MSc Wi-ETiT, MSc ETiT, BSc/MSc CE, MSc MEC, BSc/MSc iST, MSc iCE, MSc Informatik |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Lecture notes Konigorski: “Digitale Regelungssysteme”<br>Ackermann: "Abtastregelung"<br>Aström, Wittenmark: "Computer-controlled Systems"<br>Föllinger: "Lineare Abtastsysteme"<br>Phillips, Nagle: "Digital control systems analysis and design"<br>Unbehauen: "Regelungstechnik 2: Zustandsregelungen, digitale und nichtlineare Regelsysteme" |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-ko-2020-vl | **Course name**<br>Digital Control Systems I | | |
| **Instructor**<br>Prof. Dr.-Ing. Ulrich Konigorski | | **Type**<br>Lecture | **SWS**<br>2 |
| **Course Nr.**<br>18-ko-2020-ue | **Course name**<br>Digital Control Systems I | | |
| **Instructor**<br>Prof. Dr.-Ing. Ulrich Konigorski | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Fuzzy Logic, Neural Networks and Evolutionary Algorithms | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ad-2020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Jürgen Adamy | | |

| | |
|---|---|
| 1 | **Content**<br>Fuzzy systems: basics, rule based fuzzy logic, design methods, decision making, fuzzy control, pattern recognition, diagnosis; Neural networks: basics, multilayer perceptrons, radial basis functions, pattern recognition, identification, control, interpolation and approximation, Neuro-fuzzy: optimization of fuzzy systems, data driven rule generation; Evolutionary algorithms: optimization problems, evolutionary strategies and their applications, genetic programming and its applications |
| 2 | **Learning objectives / Learning Outcomes**<br>After attending the lecture, a student is capable of:<br>• recalling the elements and set-up of standardized fuzzy-logic, neural networks and evolutionary algorithms,<br>• discussing the pros and cons of certain set- ups of systems from computational intelligence for solving a given problem,<br>• recognizing situations in which tools taken from computational intelligence can be applied for problem solving,<br>• creating programs from algorithms taught in the lecture, and<br>• extending the learned standard procedures in order to solve new problems. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc iST, MSc ETiT, MSc MEC, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Adamy: Fuzzy Logik, Neuronale Netze und Evolutionäre Algorithmen, Shaker Verlag (available for purchase at the FG office)<br>www.rtr.tu-darmstadt.de (optionales Material) |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-ad-2020-vl | Fuzzy Logic, Neuronal Networks and Evolutionary Algorithms | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Jürgen Adamy | | Lecture | 2 |
| **Course Nr.** | **Course name** | | |
| 18-ad-2020-ue | Fuzzy Logic, Neuronal Networks and Evolutionary Algorithms | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Jürgen Adamy | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Technical Electrodynamics | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-dg-1070 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Herbert De Gersem | | |

| | |
|---|---|
| 1 | **Content**<br>Fields in materials, Green's functions, separation of variables in generalized orthogonal coordinates, conformal mapping, elliptic integrals and elliptic functions, electromagnetic forces, quasi-stationary fields, general waveguides, resonators, antennas. |
| 2 | **Learning objectives / Learning Outcomes**<br>Starting with Maxwell´s equations the lecture´s aim is to provide a general understanding of electromagnetic phenomena. Students will be able to apply analytical methods to simple problems. Students will exhibit the ability to deal with more complex electromagnetic formulations and tasks. |
| 3 | **Recommended prerequisite for participation**<br>Vector analysis, infinitesimal calculus, basics in differential equations. Knowledge of "Introduction to Electrodynamics" |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, MSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Course notes available (including references) |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-dg-1070-vl | Technical Electrodynamics | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann | | Lecture | 2 |
| **Course Nr.** | **Course name** | | |
| 18-dg-1070-ue | Technical Electrodynamics | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Herbert De Gersem, Dr.-Ing. Wolfgang Ackermann | | Practice | 2 |

| **Module name**<br>Electrical Machines and Drives | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-bi-1020 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

**1 Content**

Construction and function of induction machine, synchronous machine, direct current machine. Electromagnetic field within machines, armature windings, steady-state performance as motor/generator, application as line-fed and inverter-fed drives. Significance for electric power generation, both to the grid and in stand-alone version.

**2 Learning objectives / Learning Outcomes**

With active collaboration during lectures by asking questions related to those parts, which have not been completely understood by you, as well as by independent solving of examples ahead of the tutorial (not as late as during preparation for examination) you should be able to:

- calculate and explain the stationary operation performance of the three basic types of electric machine sin motor and generator mode,
- understand the application of electrical machines in modern drive systems and to design simple drive applications by yourself,
- understand and explain the function and physical background of the components of electrical machines
- understand and explain the impact of basic electromagnetic field and force theory on the basic function of electrical machines.

**3 Recommended prerequisite for participation**

Mathematics I to III, Electrical Engineering I and II, Physics, Mechanical Engineering

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc/MSc Wi-ETiT, BEd

**7 Grade bonus compliant to §25 (2)**

**8 References**

Detailed textbook and collection of exercices; Complete set of PowerPoint presentations

L.Matsch: Electromagnetic and electromechanical machines, Int.Textbook, 1972
A.Fitzgerald et al: Electric machinery, McGraw-Hill, 1971
S.Nasar et al: Electromechanics and electric machines, Wiley&Sons, 1995
R.Fischer: Elektrische Maschinen, C.Hanser-Verlag, 2004

**Courses**

| **Course Nr.**<br>18-bi-1020-vl | **Course name**<br>Electrical Machines and Drives | |
|---|---|---|
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | **Type**<br>Lecture | **SWS**<br>2 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-bi-1020-ue | Electrical Machines and Drives | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr. techn. Dr.h.c. Andreas Binder | | Practice | 2 |

| Module name<br>Programming in Automatic Control (C/C++) | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ad-1020 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Jürgen Adamy | | |

| | |
|---|---|
| 1 | **Content**<br>Programming in LINUX, Makefiles, C - Programming (Program structures in C, pointer, developer environment and debugger), C++ (object oriented programming) |
| 2 | **Learning objectives / Learning Outcomes**<br>After attending the lecture, a student is capable of:<br>1. operating LINUX computers,<br>2. assembling and using makefiles,<br>3. recalling and applying the syntax for standard C-blocks,<br>4. explaining and applying the use of pointers, 5. explaining the concept of object oriented programming in C++ |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc iST, MSc MEC, MSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Adamy: Lecture notes |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-ad-1020-vl | **Course name**<br>Programming in Automatic Control (C/C++) | | |
| | **Instructor**<br>Dr. rer. nat. Tatiana Tatarenko | | **Type**<br>Lecture | **SWS**<br>1 |
| | **Course Nr.**<br>18-ad-1020-ue | **Course name**<br>Programming in Automatic Control (C/C++) | | |
| | **Instructor**<br>Dr. rer. nat. Tatiana Tatarenko | | **Type**<br>Practice | **SWS**<br>1 |

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Sensor Technique | | | | | |
| **Module Nr.**<br>18-kn-2120 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Mario Kupnik | | |

| | |
|---|---|
| 1 | **Content** |
| 2 | **Learning objectives / Learning Outcomes**<br>The Students acquire knowledge of the different measuring methods and their advantages and disadvantages. They can understand error in data sheets and descriptions interpret in relation to the application and are thus able to select a suitable sensor for applications in electronics and information, as well process technology and to apply them correctly. |
| 3 | **Recommended prerequisite for participation**<br>Measuring Technique |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>MSc ETiT, MSc WI-ETiT, MSc MEC, MSc Medizintechnik |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>• Slide set of lecture<br>• Script of lecture<br>• Textbook Tränkler „Sensortechnik“, Springer<br>• Exercise script |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-kn-2120-vl | **Course name**<br>Sensor Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-2120-ue | **Course name**<br>Sensor Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Practice | **SWS**<br>1 |

### 3.1.3.2 AUT - Labs (open catalogue)

| **Module name**<br>Laboratory Matlab/Simulink I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ko-1030 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>45 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Ulrich Konigorski | | |

| | |
|---|---|
| **1** | **Content**<br>In this lab tutorial, an introduction to the software tool MatLab/Simulink will be given. The lab is split into two parts. First the fundamentals of programming in Matlab are introduced and their application to different problems is trained. In addition, an introduction to the Control System Toolbox will be given. In the second part, the knowledge gained in the first part is applied to solve a control engineering specific problem with the software tools. |
| **2** | **Learning objectives / Learning Outcomes**<br>Fundamentals in the handling of Matlab/Simulink and the application to control engineering tasks. |
| **3** | **Recommended prerequisite for participation**<br>The lab should be attended in parallel or after the lecture “System Dynamics and Control Systems I” |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT; BSc MEC |
| **7** | **Grade bonus compliant to §25 (2)**<br>In case of E-Learning: Possibility to improve the grade up to 1,0 |
| **8** | **References**<br>Lecture notes for the lab tutorial can be obtained at the secretariat<br>Lunze; Regelungstechnik I<br>Dorp; Bishop: Moderne Regelungssysteme<br>Moler: Numerical Computing with MATLAB |

**Courses**

| **Course Nr.**<br>18-ko-1030-pr | **Course name**<br>Laboratory Matlab/Simulink I | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Alexander Steinke | | **Type**<br>Internship | **SWS**<br>3 |

| **Module name**<br>Electronics Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1030 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| **1** | **Content**<br>Lab experiments on:<br>• Digital Circuits: FPGA programming<br>• Analog Ciruits: Basic Components, Amplifiers, Operational Amplifiers, Filters and Demodulators |
| **2** | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to<br>• perform measurement on operational amplifier circuits in the time- and frequency domain using an oscilloscope<br>• design a traffic light controller using state diagrams and download the program to a FPGA, |
| **3** | **Recommended prerequisite for participation**<br>Basics of Electrical Engineering; Lecture “Electronics” which is running in parallel |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Duration: 60 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, WI-ETiT |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References**<br>Slide Copies of Lecture “Electronics”; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-ho-1011-pr | **Course name**<br>Electronics Lab | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Ferdinand Keil | | **Type**<br>Internship | **SWS**<br>2 |
| **Course Nr.**<br>18-ho-1030-ev | **Course name**<br>Electronics Lab - Introductory Meeting | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Introductory Course | **SWS**<br>0 |

| Module name<br>Software Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

**1 Content**

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**2 Learning objectives / Learning Outcomes**

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**3 Recommended prerequisite for participation**

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/sp/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-st-1020-pr | Software Lab | | |
| **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Internship | **SWS**<br>3 |

## 3.2 Option Computer Engineering (DT)

### 3.2.1 DT - Fundamentals

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Electronics | | | | | |
| **Module Nr.**<br>18-ho-1010 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Semiconductor Devices: Diode, MOSFET, Bipolar Transistor; Design of Electronic Circuits;<br>Analog Circuits: Basic Properties, Properties and Application of Operational Amplifiers, Circuit Simulation with SPICE, Small Signal Gain, Single Stage Amplifiers; Frequency Response;<br>Digital Circuits: CMOS Logic Circuits |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to<br>• analyse Diodes, MOS- und Bipolartransistors in simple circuits<br>• calculate the properties of single transistor circuits, such as small signal gain, input and output resistance<br>• design inverting and non-inverting amplifiers from operational amplifiers and knows their ideal and non-ideal properties<br>• calculate the frequency behavior of simple transistor circuits<br>• distinguish the different methods to construct a logical gate from basic transistors and explain their fundamental properties. |
| 3 | **Recommended prerequisite for participation**<br>Basics of Electrical Engineering |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT,BSc iST, BEd |
| 7 | **Grade bonus compliant to §25 (2)**<br>A grade improvement of up to 1,0 due to a bonus is possible, which can be earned with tests. |
| 8 | **References**<br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ho-1011-vl | Electronics | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | Lecture | 2 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-ho-1011-ue | Electronics | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Communication Networks I | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-sm-1010 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| English | | | Prof. Dr.-Ing. Ralf Steinmetz | | |

**1 Content**

In this class the technologies that make today's communication networks work are introduced and discussed.

This lecture covers basic knowledge about communication networks and discusses in detail the physical layer, the data link layer, the network layer and parts of the transport layer.

The physical layer, which is responsible for an adequate transmission across a channel, is discussed briefly. Next, error control, flow control and medium access mechanisms of the data link layer are presented. Then the network layer is discussed. It comprises mainly routing and congestion control algorithms. After that basic functionalities of the transport layer are discussed. This includes UDP and TCP. The Internet is thoroughly studied throughout the class.

Detailed Topics are:

- ISO-OSI and TCP/IP layer models
- Tasks and properties of the physical layer
- Physical layer coding techniques
- Services and protocols of the data link layer
- Flow control (sliding window)
- Applications: LAN, MAN, High-Speed LAN, WAN
- Services of the network layer
- Routing algorithms
- Broadcast and Multicast routing
- Congestion Control
- Addressing
- Internet protocol (IP)
- Internetworking
- Mobile networking
- Services and protocols of the transport layer
- TCP, UDP

**2 Learning objectives / Learning Outcomes**

This lecture teaches about basic functionalities, services, protocols, algorithms and standards of network communication systems. Competencies aquired are basic knowledge about the lower four ISO-OSI layers: physical layer, datalink layer, network layer and transport layer; Furthermore, basic knowledge about communication networks is taught. Attendants will learn about the functionality of today's network technologies and the Internet.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

Wi-CS, Wi-ETiT, BSc CS, BSc ETiT, BSc iST

| | |
|---|---|
| 7 | **Grade bonus compliant to §25 (2)**<br>A bonus of 0.3 or 0.7 can be obtained.<br>For 0.3 bonus: 7 out of 9 exercises are to be solved to the best of your knowledge. That is, every question needs to be answered. However, not every question needs to be answered correctly. Additionally, at least one wiki article or applet concerning a topic of the lecture has to be provided (written).<br>For the 0.7 bonus: Additionally, present one exercise and write at least three wiki articles, or write at least 5 wiki articles.<br>An oral exam ("Fachgespräch") is mandatory in order to receive the bonus. The bonus can only be applied if the exam grade is 4.0 or better. |
| 8 | **References**<br>• Andrew S. Tanenbaum: Computer Networks, 5th Edition, Prentice Hall, 2010<br>• Andrew S. Tanenbaum: Computernetzwerke, 3. Auflage, Prentice Hall, 1998<br>• Larry L. Peterson, Bruce S. Davie: Computer Networks: A System Approach, 2nd Edition, Morgan Kaufmann Publishers, 1999<br>• Larry L. Peterson, Bruce S. Davie: Computernetze, Ein modernes Lehrbuch, 2. Auflage, Dpunkt Verlag, 2000<br>• James F. Kurose, Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 2nd Edition, Addison Wesley-Longman, 2002<br>• Jean Walrand: Communication Networks: A First Course, 2nd Edition, McGraw-Hill, 1998 |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-sm-1010-vl | **Course name**<br>Communication Networks I | | |
| **Instructor**<br>Prof. Dr.-Ing. Ralf Steinmetz | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-sm-1010-ue | **Course name**<br>Communication Networks I | | |
| **Instructor**<br>Prof. Dr.-Ing. Ralf Steinmetz | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Logic Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Boolean algebra, logic gates, hardware description languages, flipflops, sequential circuits, state-diagrams and -tables, technology mapping, programmable logic circuits |
| 2 | **Learning objectives / Learning Outcomes**<br>By this module, Students will be enabled to<br>• rewrite boolean expressions and transform them into circuits of logic gates<br>• analyze and synthesize digital circuits<br>• describe digital circuits in a hardware description language<br>• extract finite state machines from informal descriptions and implement them with synchronous circuits |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>R.H. Katz: Contemporary Logic Design |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-hb-1010-vl | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-hb-1010-ue | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Software Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

**1 Content**

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**2 Learning objectives / Learning Outcomes**

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**3 Recommended prerequisite for participation**

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/sp/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-st-1020-pr | Software Lab | | |
| **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Internship | **SWS**<br>3 |

### 3.2.2 DT - More Fundamentals

| **Module name**<br>General Computer Science II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0290 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Karsten Weihe | | |

| | |
|---|---|
| **1** | **Content**<br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |
| **2** | **Learning objectives / Learning Outcomes**<br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time |
| **3** | **Recommended prerequisite for participation**<br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers |
| **4** | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| **5** | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

| | |
|---|---|
| | Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009<br>ISBN-13: 978-3-8689-4001-5<br>Algorithmen in Java<br>Robert Sedgewick<br>Pearson Studium<br>3. überarbeitete Auflage, 2003<br>ISBN-13: 978-3-8273-7072-3<br>Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011<br>ISBN-13: 978-3-8689-4076-3 |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 20-00-0290-iv | General Computer Science II | | |
| **Instructor** | | **Type**<br>Integrated Course | **SWS**<br>4 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Analog Integrated Circuit Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1020 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

**1 Content**

Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators

**2 Learning objectives / Learning Outcomes**

A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog propierties of digital logic gates

**3 Recommended prerequisite for participation**

Lecture “Electronics”

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE

**7 Grade bonus compliant to §25 (2)**

**8 References**

Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ho-1020-vl | Analog Integrated Circuit Design | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-ho-1020-ue | Analog Integrated Circuit Design | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Electrical Power Engineering | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-bi-1010 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

**1 Content**

The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.
First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.
Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.
The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.

**2 Learning objectives / Learning Outcomes**

Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.
They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.
They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.
They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.

**3 Recommended prerequisite for participation**

Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

| | |
|---|---|
| 6 | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE |
| 7 | **Grade bonus compliant to §25 (2)**<br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades. |
| 8 | **References**<br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Renningen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.;Quaschning: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-bi-1010-vl | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-bi-1010-ue | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Introduction to Electrodynamics | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-dg-1010 | 5 CP | 150 h | 90 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Herbert De Gersem | | |

| | |
|---|---|
| 1 | **Content**<br>Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi conductor transmission lines (capacitance, inductance, and conductance matrix), velocity definitions, basics of rectangular waveguides. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space. They are able to recognice and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools. |
| 3 | **Recommended prerequisite for participation**<br>Lecture notes. Further literature recommendations are given in the course. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)**<br>Improvement by up to 0.4 due to bonus points which can be acquired by means of e-learning online tests. |
| 8 | **References**<br>Lecture notes. Further literature recommendations are given in the course. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-dg-1010-vl | **Course name**<br>Introduction to Electrodynamics | | |
| **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Lecture | **SWS**<br>2 |
| **Course Nr.**<br>18-dg-1010-ue | **Course name**<br>Introduction to Electrodynamics | | |
| **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Fundamentals of Signal Processing | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-zo-1030 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Abdelhak Zoubir | | |

**1 Content**

The course covers the following topics:

- The basic concepts of stochastic
- The sampling theorem
- Discrete-time noise processes and their properties
- Description of noise processes in the frequency domain
- Linear time-invariant systems: FIR and IIR filters
- Filtering of noise processes: AR, MA, and ARMA models
- The Matched filter
- The Wiener filter
- Properties of estimators
- The method of least squares

**2 Learning objectives / Learning Outcomes**

The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)

In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase.

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc MEC

**7 Grade bonus compliant to §25 (2)**

**8 References**

Lecture notes and slides can be downloaded here:

- http://www.spg.tu-darmstadt.de
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River,1999.

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-vl | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Lecture | 3 |

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-ue | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Practice | 1 |

| Module name<br>Microelectronic Devices | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pr-1030 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Sascha Preu | | |

**1 Content**

- Introduction: Semiconductor Devices & Microelectronic
- Semiconductor: Materials, Physics & Technology
- PN-Junction
- Metal-Oxide-Semiconductor Capacity
- Schottky Contact
- MOS-Field-Effect-Transistor (MOSFET)
- CMOS: Digital Applications
- MOS-Memory
- Bipolar- Junction-Transistor
- Outlook: Scaling Limits & SET,...

**2 Learning objectives / Learning Outcomes**

- Understand the physical properties and processes in semiconductor devices and materials
- the operation of basic semiconductor devices like diode, MOS-Transistor and bipolar transistor
- Understand functionality of basic circuits like rectifier circuit , 1-transistor amplifier and inverter from the device point of view.
- Goal: Understand state-of-the art semiconductor devices and circuits as a basis for a successful engineering career

**3 Recommended prerequisite for participation**

Electrical Engineering and Information Technology I, Electrical Engineering and Information Technology II, Laboratory ETiT, Laboratory Electronics, Mathematics I, Mathematics II, Physics

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

Skript: Microelectronic devices - the Basics

- Robert F. Pierret: Semiconductor Device Fundamentals, ISBN 0201543931
- Roger T. How, Charles G. Sodini: Microelectronics - an Integrated Approach, ISBN 0135885183
- Richard C. Jaeger: Microelectronic Circuit Design, ISBN 0071143866
- Y. Taur, T.H. Ning, Fundamentals of Modern VLSI Devices, ISBN 0521559596
- Thomas Tille, Doris Schmidt-Landsiedel: Mikroelektronik, ISBN 3540204229
- Michael Reisch: Halbleiter-Bauelemente, ISBN 3540213848

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-pr-1030-vl | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-pr-1030-ue | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Communication Technology I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kl-1020 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

**1 Content**

Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access

**2 Learning objectives / Learning Outcomes**

After completion of the lecture, students possess the ability to:

- classify signals and communication systems,
- understand, model and analyse basic components of communication systems,
- understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,
- model and analyse base-band commnication systems,
- describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,
- understand, model, evaluate, compare and apply linear modulation schemes,
- design receiver structures for different modulation schemes,
- detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,
- understand and model OFDM,
- understand and model CDMA,
- understand and compare the basic properties of multiple access schemes.

**3 Recommended prerequisite for participation**

Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC

**7 Grade bonus compliant to §25 (2)**

**8 References**

Will be announced in the lecture

**Courses**

| **Course Nr.**<br>18-kl-1020-vl | **Course name**<br>Communication Technology I | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Anja Klein | | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-kl-1020-ue | Communication Technology I | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos | | Practice | 1 |

| **Module name**<br>Fundamentals of Communication | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-jk-1010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| 1 | **Content**<br>Part 1: Chap. 1 will be a brief introduction in "Electrical Information- and Communication Engineering", presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.<br>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.<br>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.<br>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited inter-symbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture. |
| 2 | **Learning objectives / Learning Outcomes**<br>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.<br>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems. |
| 3 | **Recommended prerequisite for participation**<br>Deterministic Signals and Systems |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |

| | |
|---|---|
| 8 | **References**<br>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addision-Wesley 1992. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-jk-1010-vl | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-jk-1010-ue | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1024 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0054-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0054-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1025 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0055-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0055-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Computer Systems I | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1020 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Types of instruction sets, memory organization and its impact on the runtime, pipelining, instruction level parallelism, superscalar processors, VLIW processors, floating point numbers and operations, memory subsystem, cache types, virtual address spaces, benchmarking and performance prediction, system architecture and bus systems, peripheral devices |
| 2 | **Learning objectives / Learning Outcomes**<br>Successful students can analyze and evaluate processors, memory systems and bus systems. They can transform structures of high-level programming languages like subroutine calls into sequences of machine instructions. They are able to measure the performance of computers. They know how instructions are executed in modern processors and thus, they can predict the influence of a specific memory hierarchy onto the execution time of a given program. They know how internal and external bus systems work and can define the essential parameters for their dimension and operation. |
| 3 | **Recommended prerequisite for participation**<br>Basic knowledge of digital design as it can be obtained by the lecture “Logic Design”. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Harris & Harris: Digital Design and Computer Architecture<br>Hennessy/Patterson: Computer architecture - a quantitative approach |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-hb-1020-vl | **Course name**<br>Computer Systems I | | |
| **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-hb-1020-ue | **Course name**<br>Computer Systems I | | |
| **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Software Engineering - Introduction | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

**1 Content**

The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engi-neering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of soft-ware architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).
During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.

**2 Learning objectives / Learning Outcomes**

This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.
After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.

**3 Recommended prerequisite for participation**

sound knowledge of an object-oriented programming language (preferably Java)

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc iST, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/se-i-v/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-su-1010-vl | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-su-1010-ue | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche | | Practice | 1 |

| Module name<br>Software Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

**1 Content**

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**2 Learning objectives / Learning Outcomes**

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**3 Recommended prerequisite for participation**

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/sp/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-st-1020-pr | Software Lab | | |
| **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Internship | **SWS**<br>3 |

### 3.2.3 DT - Specialization

#### 3.2.3.1 DT - Lectures (open catalogue)

| **Module name**<br>Information Management | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0015 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

**1 Content**

Information Management Concepts:
Information systems concepts
Information storage/retrieval, searching, browsing, navigational vs. declarative access
Quality issues: consistency, scalability, availability, reliability
Data Modeling:
Conceptual data models (ER/UML structure diagr.)
Conceptual design
Operational models (relational model)
Mapping from conceptual to operational model
Relational Model:
Operators
Relational algebra
Relational calculus
Implications on query languages derived from RA and RC
Design theory, normalization
Query Languages
SQL (in detail)
QBE, Xpath, rdf (high level)
Storage media
RAID, SSDs
Buffering, caching
Implementation of relational operators:
Implementation algorithms
Cost functions
Query optimization:
Heuristic query optimization
Cost based query optimization
Transaction processing (concurrency control and recovery):
Flat transactions
Concurrency control, correctness criteria: serializability, recoverability, ACA, strictness
Isolation levels
Lock-based schedulers, 2PL
Multiversion concurrency control
Optimistic schedulers
Logging
Checkpointing
Recovery/restart
New trends in data management
Main memory databases
Column stores
NoSQL

**2 Learning objectives / Learning Outcomes**

| | |
|---|---|
| | After successfully attending the course, students are familiar with the fundamental concepts of information management. They understand the techniques for realizing information management systems and can apply the models, algorithms and languages to independently use and (partially) implement information management systems that fulfill the given requirements. They are able to evaluate such systens in a number of quality metrics. |
| **3** | **Recommended prerequisite for participation**<br>Recommended:<br>Participation of lecture „Funktionale und Objektorientierte Programmierkonzepte“ and „Algorithmen und Datenstrukturen“, respective according knowledge. |
| **4** | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0015-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| **5** | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0015-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| **6** | **Usability of this module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>May be used in other degree programs. |
| **7** | **Grade bonus compliant to §25 (2)**<br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| **8** | **References**<br>Will be updated regularly, an example might be:<br>Haerder, Rahm, “Datenbanksysteme - Konzepte und Techniken der Implementierung”, Springer 1999<br>Elmasri, R., Navathe, S. B.: Fundamentals of Database Systems, 3rd. ed., Redwood City, CA: Benjamin/Cummings<br>Ullman, J. D.: Principles of Database and Knowledge-Base Systems, Vol. 1 Computer Science |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 20-00-0015-iv | Information Management | | |
| | **Instructor** | | **Type** | **SWS** |
| | | | Integrated Course | 3 |

| **Module name**<br>Architecture and Design of Computer Systems | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0012 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

| | |
|---|---|
| 1 | **Content**<br>- Technological foundations and trends in micro electronics<br>- Design flows for microelectronic systems<br>- Description of hardware systems<br>- Characteristics of computing systems<br>- Architectural support for parallel execution<br>- Memory systems<br>- Heterogeneous systems-on-chip<br>- On-chip and off-chip communication structures<br>- Embedded systems, including in context of cyber-physical systems |
| 2 | **Learning objectives / Learning Outcomes**<br>After successfully attending the course, students are familiar with functional and non-functional requirements for heterogeneous discrete and integrated computing systems. They understand the techniques for realizing such systems and can use design methods and tools to apply the techniques to independently implement computing systems (or components thereof) that fulfill the given requirements. They are able to evaluate computing systems in a number of quality metrics. |
| 3 | **Recommended prerequisite for participation**<br>Recommended:<br>Pass of lecture „Digitaltechnik“ and „Rechnerorganisation“, respectively according knowledge. |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0012-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0012-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs. |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Literature recommendations will be updated regularly, an example might be:<br>Nikhil/Czeck: Bluespec by Example<br>Arvind/Nikhil/Emer/Vijayaraghavan: Computer Architecture: A Constructive Approach<br>Hennessy/Patterson: Computer Architecture – A Quantitative Approach<br>Crockett/Elliott/Enderwitz/Stewart: The Zynq Book<br>Flynn/Luk: Computer System Design<br>Sass/Schmidt: Embedded Systems Design |
| **Courses** | |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 20-00-0012-iv | Architecture and Design of Computer Systems | | |
| | **Instructor** | | **Type** Integrated Course | **SWS** 3 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Computer Networks and Distributed Systems | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 20-00-0016 | 5 CP | 150 h | 105 h | 1 | Every 2. Sem. |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. phil. nat. Marc Fischlin | | |

| | |
|---|---|
| 1 | **Content**<br>Overview of Net-Centric Computing (NCC), a basic element of modern computer science. Fundamental network concepts of modeling, planning and evaluating net-centric systems<br>- Foundations: Service, protococols, connection, layer model<br>- protocol mechanisms for media access, routing, broad-/multicast<br>- Multimedia Data Handling<br>- Aspects of continuous data streams and their processing<br>- Quality of service: definition and mechanisms<br>- Multimedia - Synchronisation: Basics<br>- Compression procedures; |
| 2 | **Learning objectives / Learning Outcomes**<br>- Overview knowledge of relevant areas and basic problems of net-centric computing (NCC)<br>- Reproducible comprehension of selected, elementary algorithms, protocols and procedures used in the internet<br>- Applicable methodological knowledge of widely applied elements of the modeling and engineering of NCC-systems<br>NCC is, in this context, understood as “internet technology in the broadcast sense”. It covers, in particular, themes of the "classical areas" constituted by computer networks, distributed systems, multimedia and mobile communication/ mobile computing, as those from "modern areas", such as ubiquitous/pervasive computing, peer-to-peer-computing or ambient intelligence. The canonical lecture "Introduction to NCS" focusses on the area of computer networks, the understanding of which is fundamental for all other listed areas; the latter will be the subject matter of advanced lectures in the area of NCS. |
| 3 | **Recommended prerequisite for participation**<br>Recommended:<br>Funktionale und objektorientierte Programmierkonzepte“, „Algorithmen und Datenstrukturen“, „Betriebssysteme“, „Einführung in den Compilerbau“, „Rechnerorganisation“ und „Systemnahe and parallele Programmierung“. |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0016-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0016-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs. |
| 7 | **Grade bonus compliant to §25 (2)** |

| | |
|---|---|
| | In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| **8** | **References**<br>Main literature:<br>- A. Tanenbaum, D. Wetherall: Computernetzwerke, 5te Aufl., Pearson Studium 2012<br>- (englisch: Computer Networks, 5th Ed., Prentics Hall 2010)<br>- J. Kurose, K. Ross: Computernetzwerke; Pearson Studium 2012 (also in english by Prentice Hall)<br>Selected chapters of:<br>- G. Coulouris, J. Dollimore, T. Kindberg: Distributed Systems – Concept and Design, Pearson Studium<br>- G. Krüger, D. Reschke: „Lehr- und Übungsbuch Telematik“<br>- L. Kleinrock: Queueing Systems, vol. 1 (Wiley)<br>- W.R. Stevens: Unix Network Programming, Volume 1: The Sockets Networking API (Addison Wesley) |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 20-00-0016-iv | Computer Networks and distributed Systems | | |
| | **Instructor** | | **Type** | **SWS** |
| | | | Integrated Course | 3 |

| **Module name**<br>Computer Security | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0018 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

| | |
|---|---|
| 1 | **Content**<br>Part I: Cryptography<br>- Background in Mathematics for cryptography<br>- Security objectives: Confidentiality, Integrity, Authenticity<br>- Symmetric and Asymmetric Cryptography<br>- Hash functions and digital signatures<br>- Protocols for key distribution<br>Part II: IT-Security and Dependability<br>- Basic concepts of IT security<br>- Authentication and biometrics<br>- Access control models and mechanisms<br>- Basic concepts of network security<br>- Basic concepts of software security<br>- Dependable systems: error tolerance, redundancy, availability |
| 2 | **Learning objectives / Learning Outcomes**<br>After successfully attending the course, students are familiar with the basic concepts, methods and models in the areas of cryptography and computer security. They understand the most important methods that allow to secure software and hardware systems against attackers and are able to apply this knowledge to concrete application scenarios. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0018-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0018-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs. |
| 7 | **Grade bonus compliant to §25 (2)**<br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| 8 | **References**<br>- J. Buchmann, Einführung in die Kryptographie, Springer-Verlag, 2010<br>- C. Eckert, IT-Sicherheit, Oldenbourg Verlag, 2013<br>- M. Bishop, Computer Security: Art and Science, Addison Wesley, 2004 |
| **Courses** | |

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>20-00-0018-iv | **Course name**<br>Computer Security | | |
| | **Instructor** | | **Type**<br>Integrated Course | **SWS**<br>3 |

| **Module name**<br>Information Management | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0015 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

**1 Content**

Information Management Concepts:
Information systems concepts
Information storage/retrieval, searching, browsing, navigational vs. declarative access
Quality issues: consistency, scalability, availability, reliability
Data Modeling:
Conceptual data models (ER/UML structure diagr.)
Conceptual design
Operational models (relational model)
Mapping from conceptual to operational model
Relational Model:
Operators
Relational algebra
Relational calculus
Implications on query languages derived from RA and RC
Design theory, normalization
Query Languages
SQL (in detail)
QBE, Xpath, rdf (high level)
Storage media
RAID, SSDs
Buffering, caching
Implementation of relational operators:
Implementation algorithms
Cost functions
Query optimization:
Heuristic query optimization
Cost based query optimization
Transaction processing (concurrency control and recovery):
Flat transactions
Concurrency control, correctness criteria: serializability, recoverability, ACA, strictness
Isolation levels
Lock-based schedulers, 2PL
Multiversion concurrency control
Optimistic schedulers
Logging
Checkpointing
Recovery/restart
New trends in data management
Main memory databases
Column stores
NoSQL

**2 Learning objectives / Learning Outcomes**

| | |
|---|---|
| | After successfully attending the course, students are familiar with the fundamental concepts of information management. They understand the techniques for realizing information management systems and can apply the models, algorithms and languages to independently use and (partially) implement information management systems that fulfill the given requirements. They are able to evaluate such systens in a number of quality metrics. |
| **3** | **Recommended prerequisite for participation**<br>Recommended:<br>Participation of lecture „Funktionale und Objektorientierte Programmierkonzepte“ and „Algorithmen und Datenstrukturen“, respective according knowledge. |
| **4** | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0015-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| **5** | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0015-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| **6** | **Usability of this module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>May be used in other degree programs. |
| **7** | **Grade bonus compliant to §25 (2)**<br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| **8** | **References**<br>Will be updated regularly, an example might be:<br>Haerder, Rahm, “Datenbanksysteme - Konzepte und Techniken der Implementierung”, Springer 1999<br>Elmasri, R., Navathe, S. B.: Fundamentals of Database Systems, 3rd. ed., Redwood City, CA: Benjamin/Cummings<br>Ullman, J. D.: Principles of Database and Knowledge-Base Systems, Vol. 1 Computer Science |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 20-00-0015-iv | Information Management | | |
| | **Instructor** | | **Type** | **SWS** |
| | | | Integrated Course | 3 |

| **Module name**<br>Serious Games | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0366 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr. Bernt Schiele | | |

| | |
|---|---|
| 1 | **Content**<br>Introduction to the topic of “”Serious Games"": scientific and technical foundations, application areas and trends. Individual lectures include:<br>* Introduction to Serious Games<br>* Game Development, Game Design<br>* Game Technology, Tools and Engines<br>* Personalization and Adaptation<br>* Interactive Digital Storytelling<br>* Authoring and Content Generation<br>* Multiplayer Games<br>* Game Interfaces and Sensor Technology<br>* Effects, Affects and User Experience<br>* Mobile Games<br>* Serious Games Application Domains and Best Practice Examples<br>The exercise consists of theoretical and practical parts. Students are taught how to use a Game Engine. |
| 2 | **Learning objectives / Learning Outcomes**<br>After successfully completing this course the students are able to explain the concept of “Serious Games” and can transfer it to different application domains (like education or health). They can describe the general approach for developing computer games and can apply basic principles of game design, personalisation / adaptation and interactive digital storytelling. Aside from that students are able to sketch out other current research questions regarding Serious Games as well as their solutions. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0366-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0366-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>B.Sc. Informatik<br>M.Sc. Informatik<br>B.Sc. Computational Engineering<br>M.Sc. Computational Engineering<br>M.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>Can be used in other degree programs. |
| 7 | **Grade bonus compliant to §25 (2)**<br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| 8 | **References** |

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|---|---|
| | Will be given in lecture. |

**Courses**

| | | | |
|---|---|---|---|
| | **Course Nr.**<br>20-00-0366-iv | **Course name**<br>Serious Games | |
| | **Instructor** | **Type**<br>Integrated Course | **SWS**<br>4 |

| **Module name**<br>Modeling, Specification and Semantics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0013 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

| | |
|---|---|
| 1 | **Content**<br>- introduction to modeling using predicate logic and algebraic concepts<br>- interpretation and faithfulness of formal models<br>- systematic construction of models and making of design decisions<br>- abstraction, refinement, composition, and decomposition of models<br>- syntax and operational semantics of programming languages<br>- elementary proof techniques and their use<br>- introduction to specification languages<br>- syntax and denotational semantics of specification languages<br>- modeling communication and coordination in concurrent systems<br>- taxonomy of system properties |
| 2 | **Learning objectives / Learning Outcomes**<br>After successfully participating in this course, students know basic concepts in the areas modeling, specification, and semantics. They are able to use predicate logic and algebraic concepts to formalize given, informally described scenarios. They are able to develop formal models in a systematic fashion, to make necessary design decisions, and to employ informal notation and graphics to facilitate the construction of formal models. They know selected formal specfication languages and are able to apply at least one such language. They understand the distinction between the syntax and semantics of formal languages and are able to prove propositions about expressions as well as simple meta-properties about the languages themselves. They are able to formalize basic system requirements as predicates and can assess the faithfulness of such formalizations. |
| 3 | **Recommended prerequisite for participation**<br>Recommended:<br>Participation of lecture “Automaten, formale Sprachen und Entscheidbarkeit” and “Aussagen- und Prädikatenlogik”, respective according knowledge. |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0013-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0013-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>May be used in other degree programs. |
| 7 | **Grade bonus compliant to §25 (2)**<br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| 8 | **References** |

U. Kastens, H. Kleine Büning: Modellierung - Grundlagen und formale Methoden, Hanser
G. Winskel: The Formal Semantics of Programming Languages, MIT Press
C. A. R. Hoare: Communicating Sequential Processes, Prentice-Hall
Literature recommendations will be updated regularly.

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 20-00-0013-iv | Modellierung, Spezifikation und Semantik | | |
| **Instructor** | | **Type** | **SWS** |
| | | Integrated Course | 3 |

| **Module name**<br>Modelling and simulation of circuits | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-sc-2010 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr. rer. nat. Sebastian Schöps | | |

**1 Content**

The content of this course is the following:

- Circuit interpretation as directed graphs
- Modified nodal and loop analysis
- Flux and charge oriented formulations
- Differential algebraic equations
- Linear system solver
- Numerical solution of nonlinear systems
- Time-domain methods
- Frequency-domain solution
- Implementation of the numerical methods

**2 Learning objectives / Learning Outcomes**

Students understand the theoretical and numerical fundamentals of circuit simulation and how the equations can be derived from Maxwell's equations. Circuit properties can be expressed in tems of graph theory. The sparse systems of equations such as the flux/charge oreinted modified nodal analysis can be assembled. In order to solve the obtained systems, different numerical methods for the simulation of circuits are relevant. This includes methods for the solution of linear systems (direct and iterative solvers), root-finding algorithms for nonlinear systems and implicit time integration methods. Mathematical concepts such as stability, convergence order or complexity are known and can be employed to judge the advantages and disadvantages of the various methods. Eventually, the students are able to programm their own circuit simulator, that can return both frequency as well as time domain solutions of electric networks.

**3 Recommended prerequisite for participation**

18-hs-1070 Elektrotechnik und Informationstechnik I
18-gt-1020 Elektrotechnik und Informationstechnik II
20-00-0304 Allgemeine Informatik I
04-00-0112 Mathematik IV

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Oral Examination, Duration: 20 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Oral Examination, Weighting: 100 %)

**6 Usability of this module**

**7 Grade bonus compliant to §25 (2)**

Grade bonus of 0,4 if correctly implemented programs are submitted

**8 References**

- L. W. Nagel, “SPICE2: A computer program to simulate semiconductor circuits”, University of Berkeley, Tech. Rep., 1975.
- C.-W. Ho, A. E. Ruehli, and P. A. Brennan, “The modified nodal approach to network analysis”, IEEE Trans. Circ. Syst., vol. 22, no. 6, pp. 504–509, Jun. 1975.
- J. Vlach, K. Singhal, Computer methods for circuit analysis and design. New York : Van Nostrand Reinold, 1983.


**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-sc-2010-vl | Modelling and simulation of circuits | | |
| **Instructor** | | **Type** Lecture | **SWS** 2 |
| **Course Nr.** | **Course name** | | |
| 18-sc-2010-ue | Modelling and simulation of circuits | | |
| **Instructor** | | **Type** Practice | **SWS** 1 |

### 3.2.3.2 DT - Labs and Proseminars (open catalogue)

| **Module name**<br>Electronics Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1030 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| **1** | **Content**<br>Lab experiments on:<br>• Digital Circuits: FPGA programming<br>• Analog Ciruits: Basic Components, Amplifiers, Operational Amplifiers, Filters and Demodulators |
| **2** | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to<br>• perform measurement on operational amplifier circuits in the time- and frequency domain using an oscilloscope<br>• design a traffic light controller using state diagrams and download the program to a FPGA, |
| **3** | **Recommended prerequisite for participation**<br>Basics of Electrical Engineering; Lecture “Electronics” which is running in parallel |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Duration: 60 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, WI-ETiT |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References**<br>Slide Copies of Lecture “Electronics”; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-ho-1011-pr | **Course name**<br>Electronics Lab | | |
| | **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Ferdinand Keil | | **Type**<br>Internship | **SWS**<br>2 |
| | **Course Nr.**<br>18-ho-1030-ev | **Course name**<br>Electronics Lab - Introductory Meeting | | |
| | **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Introductory Course | **SWS**<br>0 |

| Module name | | | | | |
|---|---|---|---|---|---|
| C/C++ Programming Lab | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1030 | 3 CP | 90 h | 45 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

| | |
|---|---|
| 1 | **Content**<br>The six-day programming lab is divided into two sections.<br>In the first four days, the programming languages C and C++ are taught with practical tasks and lectures. All covered aspects are extensively practiced under supervision. Based on the fundamental basics of C++, manual memory management and dynamic data structures are handled from a procedural as well as from an object-oriented perspective. Object orientation with C++ is extensively addressed by treating multiple inheritance, polymorphism and parametric polymorphism.<br>The last two days are dedicated to microcontroller programming in C including the opportunity of programming of a distributed application (via a CAN-bus). |
| 2 | **Learning objectives / Learning Outcomes**<br>During the lab, the students acquire a fundamental understanding of the programming languages C and C++ with emphasis not only on procedural but also on object-oriented characteristics. The students gain hands-on experience with applying C++ and discover the challenges of using C++ safely and properly especially in the context of embedded system software development. |
| 3 | **Recommended prerequisite for participation**<br>Java skills |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-su-1030-pr | C/C++ Programming Lab | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr | | Internship | 3 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Digital Design Lab | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1030 | 3 CP | 90 h | 45 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

**1 Content**

- Introduction to the MP3 encoding standard for audio signals
- Analysis of the individual steps of the decoding process wrt. the used algo-rithms
- Analysis of the individual steps of the decoding process wrt. the storage of in-termediate results
- Design and configuration of the datapath to realize the individual process steps
- Simulation on functional level and with timing annotation
- Check, whether the design meets all restrictions
- Test of the final HW design with all relevant MP3 variants (short and long frames)

**2 Learning objectives / Learning Outcomes**

Students are able to manually map complex problems onto a digital target architecture. They are proficient in using the design tools to implement their solution on FPGAs. They know strategies to systematically find errors in their design. They can explore de-signs by simulation.

**3 Recommended prerequisite for participation**

Basic knowledge of digital design

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Oral Examination, Duration: 30 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Oral Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc iST

**7 Grade bonus compliant to §25 (2)**

**8 References**

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-hb-1030-pr | Digital Design Lab | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Christian Hochberger | | Internship | 3 |

| **Module name**<br>Multimedia Communications Lab I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-sm-1020 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>45 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr.-Ing. Ralf Steinmetz | | |

**1 Content**

The course deals with cutting edge development topics in the area of multimedia communication systems. Beside a general overview it provides a deep insight into a special development topic. The topics are selected according to the specific working areas of the participating researchers and convey technical and basic scientific competences in one or more of the following topics:

- Network planning and traffic analysis
- Performance evaluation of network applications
- Discrete event simulation for network services
- Protocols for mobile ad hoc networks / sensor networks
- Infrastructure networks for mobile communication / mesh networks
- Context-aware communication and services
- Peer-to-peer systems and architectures
- Content distribution and management systems for multimedia/e-learning
- Multimedia authoring and re-authoring tools
- Web service technologies and service-oriented architectures
- Applications for distributed workflows
- Resource-based Learning

**2 Learning objectives / Learning Outcomes**

The ability to solve simple problems in the area of multimedia communication shall be acquired. Acquired competences are:

- Design of simple communication applications and protocols
- Implementing and testing of software components for distributed systems
- Application of object-oriented analysis and design techniques
- Presentation of project advances and outcomes

**3 Recommended prerequisite for participation**

Keen interest to explore basic topics of cutting edge communication and multimedia technologies. Further we expect:

- Basic experience in programming Java/C# (C/C++).
- Knowledge in computer communication networks. Lectures in Communication Networks I and/or Net Centric Systems are recommended.

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc/MSc iST, MSc MEC, Wi-CS, Wi-ETiT, BSc/MSc CS

**7 Grade bonus compliant to §25 (2)**

**8 References**

Each topic is covered by a selection of papers and articles. In addition we recommend reading of selected chapters from following books:

- Andrew Tanenbaum: “Computer Networks”. Prentice Hall PTR (ISBN 0130384887)
- Christian Ullenboom: "Java ist auch eine Insel: Programmieren mit der Java Standard Edition Version 5 / 6" (ISBN-13: 978-3898428385)
- Kent Beck: "Extreme Programming Explained - Embrace Changes" (ISBN-13: 978-0321278654)

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-sm-1020-pr | Multimedia Communications Lab I | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ralf Steinmetz, M.Sc. Daniel Bischoff, M.Sc. Tim Steuer | | Internship | 3 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Project Seminar Computer Systems | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1040 | 9 CP | 270 h | 210 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Students elaborate on a research-oriented subject in the area of computer-systems. They present a written documentation and a presentation of the acquired advanced knowledge. They provide a set of alternative solutions to a given problem. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students are able to systematically develop design alternatives to a given problem. They learn to acquire the necessary fundamental knowledge in terms of references and terminology. |
| 3 | **Recommended prerequisite for participation**<br>Basic knowledge of digital design |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc/MSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 18-hb-1040-pj | Project Seminar Computer Systems | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Christian Hochberger | | Project Seminar | 4 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Project Seminar Energy Information Systems | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-st-1010 | 9 CP | 270 h | 210 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Florian Steinke | | |

| | |
|---|---|
| 1 | **Content**<br>Students elaborate on a research-oriented subject in the area of computer-systems. They present a written documentation and/or a presentation of the acquired advanced knowledge. They provide a set of alternative solutions to a given problem. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students are able to systematically develop design alternatives to a given problem. They learn to acquire the necessary fundamental knowledge in terms of references and terminolo-gy. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 18-st-1010-pj | Project Seminar Energy Information Systems | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr. rer. nat. Florian Steinke | | Project Seminar | 4 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1000 | 2 CP | 60 h | 30 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

| | |
|---|---|
| 1 | **Content**<br>In this course, the students produce scientific reports from changing subject areas. Each student has to explore a subject related to IT system development and produce a written report as well as a final talk with a presentation. A list of the subjects of the current semester is available at www.es.tu-darmstadt.de/lehre/sst. |
| 2 | **Learning objectives / Learning Outcomes**<br>After a successful participation, the students will be able to explore an unknown topic under scientific aspects. The students learn to support the exploration by a literature research and to analyze the subject critically. They achieve the skills to present a definite subject in a written report as well as in an oral presentation. |
| 3 | **Recommended prerequisite for participation**<br>Introduction to Computer Science for Engineers, Software Lab; Software Engineering I or comparable skills |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, Informatik, iST, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>http://www.es.tu-darmstadt.de/lehre/proseminar-etit/ |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 18-su-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr. rer. nat. Andreas Schürr | | Introductory Seminar Course | 2 |

| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-hb-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| **Course Nr.**<br>18-hb-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | |
|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-st-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Florian Steinke | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.<br>Additional information can be found here. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 18-st-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr. rer. nat. Florian Steinke, M.Sc. Christopher Thomas Peter Ripp | | Introductory Seminar Course | 2 |

| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| **1** | **Content**<br>Analysis of basic electronic circuits and presentation of selected examples |
| **2** | **Learning objectives / Learning Outcomes**<br>After attending the seminar, a student is capable of analysing basic electronic circuits and preparing didactical materials and presentations |
| **3** | **Recommended prerequisite for participation**<br>Electronics |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References**<br>Will be provided at the begin of the seminar |

**Courses**

| **Course Nr.**<br>18-ho-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | |
|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-sm-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Ralf Steinmetz | | |

**1 Content**

Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.
This seminar addresses students of Electrical Engineering disciplines and covers various topics from the fields of computer science and electrical engineering. It is usually the first seminar that students take during their studies. Therefore, the focus lies on the process of finding, reading, and understanding scientific publications (conference papers, articles) related to a given topics and on categorizing and summarizing the results in oral form (presentation) and written form (short paper). Some potential topics are:

- Knowledge & Educational Technologies
- Adaptive Communication Systems
- Multimedia Technologies & Serious Games

For more information please refer to the webpage: https://www.kom.tu-darmstadt.de/en/teaching/current-courses/11/proseminar-etit/

**2 Learning objectives / Learning Outcomes**

The students will be able to understand and analyse scientific papers, as well as to present technical facts in a proper and well structured manner. They know how to summarize and present publications from a given topic area.

**3 Recommended prerequisite for participation**

Solid knowledge in computer communication networks. Lectures in Communication Networks I and II are recommended

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc MEC, BSc iST

**7 Grade bonus compliant to §25 (2)**

**8 References**

Depending on specific topic (selected articles of journals, magazines, and conferences).

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-sm-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ralf Steinmetz | | Introductory Seminar Course | 2 |

## 3.3 Option Electrical Power Engineering (EET)

### 3.3.1 EET - Fundamentals

| **Module name**<br>Electrical Power Engineering | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-bi-1010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

**1 Content**

The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.

First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.

Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.

The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.

**2 Learning objectives / Learning Outcomes**

Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.

They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.

They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.

They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.

**3 Recommended prerequisite for participation**

Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

| | |
|---|---|
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE |
| **7** | **Grade bonus compliant to §25 (2)**<br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades. |
| **8** | **References**<br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Renningen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.;Quaschning: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-bi-1010-vl | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-bi-1010-ue | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Measuring Technique | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-kn-1011 | 6 CP | 180 h | 105 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. Mario Kupnik | | |

**1 Content**

The module includes theoretical discussion and practical application of the measuring chain in detail on example the electrical variables (current, voltage, impedance, power) and selected non-electrical variables (frequency, time, force, pressure and acceleration).
In the lecture the following chapter will be thematically treated measuring signals and measuring equipment (oscilloscope, laboratory testing equipment), static measurement error and disturbance variables (especially temperature), basic measurement circuits, AD conversion principles and filtering, measurement method non-electrical variables and the statistics of measurements (distributions, statist safe tests).
The topics of the lecture are discussed in the exercise of the module. Examples are analyzed and their application in measurement scenarios are practiced.
The practicum of the module consists of five experiments which are time closely matched in time to the lecture:

- Measuring of signals in the time range with digital storage oscilloscope, trigger conditions
- Measuring of signals in the frequency range with digital storage oscilloscope, error of measurement (aliasing / subsampling, leackage) and window functions
- Measuring of mechanical dimensions with suitable primary sensors, sensor electronics / amplifier circuits
- computer-based measuring
- Importing of sensor signals, whose processing and the resulting automated control of a process using a programmable logic controller (PLC)

**2 Learning objectives / Learning Outcomes**

The students know the structure of the measuring chain and the specific properties of the corresponding elements. They know the structure of electronic measuring instruments and basic measuring circuits for electrical and selected non-electrical variables and can apply them. They know the basics of capturing, processing, transferring and storage of measurement data and can describe error sources and quantifying their influences.
In the practicum, the students deepen the basis of the measurements with the oscilloscope, the understanding of the relationship between time and frequency range. Methodically they are able to document and evaluate the data during laboratory measuring.

**3 Recommended prerequisite for participation**

Basics of ETiT I-III, Math I-III, Electronic

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Standard BWS)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 4)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Weighting: 2)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc MEC

| | | | | |
|---|---|---|---|---|
| 7 | **Grade bonus compliant to §25 (2)** | | | |
| 8 | **References**<br>• Slide set of lecture<br>• Textbook and exercise book Lerch: „Elektrische Messtechnik“, Springer<br>• Exercise documents<br>• Practical experiment manuals | | | |
| **Courses** | | | | |
| | **Course Nr.**<br>18-kn-1011-vl | **Course name**<br>Measuring Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1011-pr | **Course name**<br>Measuring Technique Lab | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Internship | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1011-ue | **Course name**<br>Measuring Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| System Dynamics and Automatic Control Systems I | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ko-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Ulrich Konigorski | | |

| | |
|---|---|
| 1 | **Content**<br>Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, MSc Informatik |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Skript Konigorski: “Systemdynamik und Regelungstechnik I”, Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen", Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen", Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation", Jörgl: "Repetitorium Regelungstechnik", Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden", Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise", Schneider: "Regelungstechnik für Maschinenbauer", Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage" |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ko-1010-vl | System Dynamics and Automatic Control Systems I | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-ko-1010-tt | System Dynamics and Automatic Control Systems I- Auditorium Exercise | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand | | Tutorial | 1 |

| **Module name**<br>General Computer Science II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0290 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Karsten Weihe | | |

| | |
|---|---|
| 1 | **Content**<br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time |
| 3 | **Recommended prerequisite for participation**<br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module** |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009
ISBN-13: 978-3-8689-4001-5
Algorithmen in Java
Robert Sedgewick
Pearson Studium
3. überarbeitete Auflage, 2003
ISBN-13: 978-3-8273-7072-3
Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011
ISBN-13: 978-3-8689-4076-3

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 20-00-0290-iv | General Computer Science II | | |
| **Instructor** | | **Type** Integrated Course | **SWS** 4 |

| **Module name**<br>Analog Integrated Circuit Design | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1020 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog propierties of digital logic gates |
| 3 | **Recommended prerequisite for participation**<br>Lecture “Electronics” |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-ho-1020-vl | **Course name**<br>Analog Integrated Circuit Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-ho-1020-ue | **Course name**<br>Analog Integrated Circuit Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Electronics | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1010 | 4 CP | 120 h | 75 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

**1 Content**

Semiconductor Devices: Diode, MOSFET, Bipolar Transistor; Design of Electronic Circuits;
Analog Circuits: Basic Properties, Properties and Application of Operational Amplifiers, Circuit Simulation with SPICE, Small Signal Gain, Single Stage Amplifiers; Frequency Response;
Digital Circuits: CMOS Logic Circuits

**2 Learning objectives / Learning Outcomes**

A student is, after successful completion of this module, able to

- analyse Diodes, MOS- und Bipolartransistors in simple circuits
- calculate the properties of single transistor circuits, such as small signal gain, input and output resistance
- design inverting and non-inverting amplifiers from operational amplifiers and knows their ideal and non-ideal properties
- calculate the frequency behavior of simple transistor circuits
- distinguish the different methods to construct a logical gate from basic transistors and explain their fundamental properties.

**3 Recommended prerequisite for participation**

Basics of Electrical Engineering

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT,BSc iST, BEd

**7 Grade bonus compliant to §25 (2)**

A grade improvement of up to 1,0 due to a bonus is possible, which can be earned with tests.

**8 References**

Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ho-1011-vl | Electronics | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | Lecture | 2 |
| **Course Nr.** | **Course name** | | |
| 18-ho-1011-ue | Electronics | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Electronics Lab | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1030 | 3 CP | 90 h | 60 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Lab experiments on:<br>• Digital Circuits: FPGA programming<br>• Analog Ciruits: Basic Components, Amplifiers, Operational Amplifiers, Filters and Demodulators |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to<br>• perform measurement on operational amplifier circuits in the time- and frequency domain using an oscilloscope<br>• design a traffic light controller using state diagrams and download the program to a FPGA, |
| 3 | **Recommended prerequisite for participation**<br>Basics of Electrical Engineering; Lecture “Electronics” which is running in parallel |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Duration: 60 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, WI-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Slide Copies of Lecture “Electronics”; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-ho-1011-pr | **Course name**<br>Electronics Lab | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Ferdinand Keil | | **Type**<br>Internship | **SWS**<br>2 |
| **Course Nr.**<br>18-ho-1030-ev | **Course name**<br>Electronics Lab - Introductory Meeting | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Introductory Course | **SWS**<br>0 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Introduction to Electrodynamics | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-dg-1010 | 5 CP | 150 h | 90 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Herbert De Gersem | | |

| | |
|---|---|
| 1 | **Content**<br>Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi conductor transmission lines (capacitance, inductance, and conductance matrix), velocity definitions, basics of rectangular waveguides. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space. They are able to recognice and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools. |
| 3 | **Recommended prerequisite for participation**<br>Lecture notes. Further literature recommendations are given in the course. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)**<br>Improvement by up to 0.4 due to bonus points which can be acquired by means of e-learning online tests. |
| 8 | **References**<br>Lecture notes. Further literature recommendations are given in the course. |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-dg-1010-vl | **Course name**<br>Introduction to Electrodynamics | | |
| | **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-dg-1010-ue | **Course name**<br>Introduction to Electrodynamics | | |
| | **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Practice | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Fundamentals of Signal Processing | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-zo-1030 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Abdelhak Zoubir | | |

| | |
|---|---|
| 1 | **Content**<br>The course covers the following topics:<br>• The basic concepts of stochastic<br>• The sampling theorem<br>• Discrete-time noise processes and their properties<br>• Description of noise processes in the frequency domain<br>• Linear time-invariant systems: FIR and IIR filters<br>• Filtering of noise processes: AR, MA, and ARMA models<br>• The Matched filter<br>• The Wiener filter<br>• Properties of estimators<br>• The method of least squares |
| 2 | **Learning objectives / Learning Outcomes**<br>The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)<br>In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase. |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

Lecture notes and slides can be downloaded here:

- http://www.spg.tu-darmstadt.de
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River,1999.

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-vl | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Lecture | 3 |

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-ue | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Microelectronic Devices | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-pr-1030 | 4 CP | 120 h | 75 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Sascha Preu | | |

**1 Content**

- Introduction: Semiconductor Devices & Microelectronic
- Semiconductor: Materials, Physics & Technology
- PN-Junction
- Metal-Oxide-Semiconductor Capacity
- Schottky Contact
- MOS-Field-Effect-Transistor (MOSFET)
- CMOS: Digital Applications
- MOS-Memory
- Bipolar- Junction-Transistor
- Outlook: Scaling Limits & SET,...

**2 Learning objectives / Learning Outcomes**

- Understand the physical properties and processes in semiconductor devices and materials
- the operation of basic semiconductor devices like diode, MOS-Transistor and bipolar transistor
- Understand functionality of basic circuits like rectifier circuit , 1-transistor amplifier and inverter from the device point of view.
- Goal: Understand state-of-the art semiconductor devices and circuits as a basis for a successful engineering career

**3 Recommended prerequisite for participation**

Electrical Engineering and Information Technology I, Electrical Engineering and Information Technology II, Laboratory ETiT, Laboratory Electronics, Mathematics I, Mathematics II, Physics

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

Skript: Microelectronic devices - the Basics

- Robert F. Pierret: Semiconductor Device Fundamentals, ISBN 0201543931
- Roger T. How, Charles G. Sodini: Microelectronics - an Integrated Approach, ISBN 0135885183
- Richard C. Jaeger: Microelectronic Circuit Design, ISBN 0071143866
- Y. Taur, T.H. Ning, Fundamentals of Modern VLSI Devices, ISBN 0521559596
- Thomas Tille, Doris Schmidt-Landsiedel: Mikroelektronik, ISBN 3540204229
- Michael Reisch: Halbleiter-Bauelemente, ISBN 3540213848

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-pr-1030-vl | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-pr-1030-ue | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Communication Technology I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kl-1020 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

**1 Content**

Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access

**2 Learning objectives / Learning Outcomes**

After completion of the lecture, students possess the ability to:

- classify signals and communication systems,
- understand, model and analyse basic components of communication systems,
- understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,
- model and analyse base-band commnication systems,
- describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,
- understand, model, evaluate, compare and apply linear modulation schemes,
- design receiver structures for different modulation schemes,
- detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,
- understand and model OFDM,
- understand and model CDMA,
- understand and compare the basic properties of multiple access schemes.

**3 Recommended prerequisite for participation**

Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC

**7 Grade bonus compliant to §25 (2)**

**8 References**

Will be announced in the lecture

**Courses**

| **Course Nr.**<br>18-kl-1020-vl | **Course name**<br>Communication Technology I | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Anja Klein | | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-kl-1020-ue | Communication Technology I | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Logic Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Boolean algebra, logic gates, hardware description languages, flipflops, sequential circuits, state-diagrams and -tables, technology mapping, programmable logic circuits |
| 2 | **Learning objectives / Learning Outcomes**<br>By this module, Students will be enabled to<br>• rewrite boolean expressions and transform them into circuits of logic gates<br>• analyze and synthesize digital circuits<br>• describe digital circuits in a hardware description language<br>• extract finite state machines from informal descriptions and implement them with synchronous circuits |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>R.H. Katz: Contemporary Logic Design |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-hb-1010-vl | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-hb-1010-ue | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Fundamentals of Communication | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-jk-1010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| 1 | **Content**<br>Part 1: Chap. 1 will be a brief introduction in "Electrical Information- and Communication Engineering", presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.<br>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.<br>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.<br>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited inter-symbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture. |
| 2 | **Learning objectives / Learning Outcomes**<br>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.<br>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems. |
| 3 | **Recommended prerequisite for participation**<br>Deterministic Signals and Systems |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |

| | |
|---|---|
| 8 | **References**<br>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addision-Wesley 1992. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-jk-1010-vl | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-jk-1010-ue | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1024 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0054-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0054-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1025 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0055-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0055-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Software Engineering - Introduction | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

**1 Content**

The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engi-neering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of soft-ware architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).
During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of requirements, definition of a design and eventually the implementation of executable (proof-of-concept) code.

**2 Learning objectives / Learning Outcomes**

This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.
After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Furthermore, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal.

**3 Recommended prerequisite for participation**

sound knowledge of an object-oriented programming language (preferably Java)

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc iST, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/se-i-v/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-su-1010-vl | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-su-1010-ue | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche | | Practice | 1 |

| Module name<br>Software Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

**1 Content**

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**2 Learning objectives / Learning Outcomes**

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**3 Recommended prerequisite for participation**

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/sp/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-st-1020-pr | Software Lab | | |
| **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Internship | **SWS**<br>3 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Technical Mechanics for Electrical Engineering | | | | | |
| **Module Nr.**<br>16-26-6400 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Tobias Melz | | |

**1 Content**

Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.
Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.
Kinematics: point and rigid body movement.
Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact.

**2 Learning objectives / Learning Outcomes**

In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

**7 Grade bonus compliant to §25 (2)**

**8 References**

Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4
Exercises are embodied in the book.
Further reading:
Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6
Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2
Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1
Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).
Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt.

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 16-26-6400-vl | Technical Mechanics for Electrical Engineering | | |
| **Instructor** | | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 16-26-6400-ue | Technical Mechanics for Electrical Engineering | | |
| | **Instructor** | | **Type** | **SWS** |
| | | | Practice | 2 |

### 3.3.3.1 EET - Electric Power Systems

| **Module name**<br>Energy Management and Optimization | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-2010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

| | |
|---|---|
| 1 | **Content**<br>The lecture reviews the different levels of energy management. It then focuses on economic dispatch and discusses its different use cases like optimization of self-consumption, virtual power plants, electric vehicle load management or multi-modal neighborhood optimization. Relevant knowledge about the components to be controlled as well as the markets to be addressed is explained.<br>After this introduction to economic dispatch's application environment, the lecture focuses on the methods employed. The underlying mathematical formulations as different types of optimization problems (LP, MILP, QP, stochastic optimization) are reviewed. In parallel, a practical introduction to numerical optimization is given (descent algorithms, convergence, convexity, programming languages for the formulation of optimization problems). Moreover, an introduction into simple methods for the prognosis of future values (linear regression) is provided.All methodological learning is accompanied by hands-on exercises using the Matlab/Octave and the GAMS/AMPL software environments. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students know the different use cases and formulations of economic dispatch. They have a basic understanding of the typically employed optimization methods and are able to judge the quality of the achieved results.<br>Moreover, students are independently able to formulate (energy) optimization problems and solve them with the tool GAMS/AMPL. |
| 3 | **Recommended prerequisite for participation**<br>Standard knowledge of linear algebra and multivariate analysis as well as basic knowledge in the use of Matlab/Octave is required. Knowledge of the modules „Kraftwerke & EE“ or „Energiewirtschaft“ is helpful but not necessarry. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>MSc ETiT, MSc iST, MSc Wi-ETiT, MSc CE |
| 7 | **Grade bonus compliant to §25 (2)**<br>Improvement of grades up to 0.4 compliant to APB §25(2) through bonus system for re-gular attention of exercises and practical courses |
| 8 | **References**<br>Boyd, Vandenberghe: Convex Optimization, Cambridge University Press, 2004A GAMS Tutorial by Richard E. Rosenthal, https://www.gams.com/24.8/docs/userguides/userguide/_u_g__tutorial.html |
| **Courses** | |

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-st-2010-vl | **Course name**<br>Energy Management and Optimization | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-st-2010-pr | **Course name**<br>Energy Management and Optimization Lab | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Internship | **SWS**<br>1 |
| | **Course Nr.**<br>18-st-2010-ue | **Course name**<br>Energy Management and Optimization | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Power Systems I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-hs-1010 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Jutta Hanson | | |

| | |
|---|---|
| 1 | **Content**<br>Three-phase network and symmetrical components; overhead lines; cables; transformers; calculation of short-circuit currents; switch equipment; switchgears |
| 2 | **Learning objectives / Learning Outcomes**<br>The education goals are<br>• Presentation of components of power system<br>• Functional elaboration of equipment<br>• Calculation of the component rating<br>• Impact on the electrical power system |
| 3 | **Recommended prerequisite for participation**<br>Contents of the lecture Electrical Power Engineering |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc/MSc WI-ET, BSc EPE, BSc/MSc CE, BSc/MSc iST, MSc Informatik |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Script, lecture slides, guiding questions, excercises |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-hs-1010-vl | **Course name**<br>Power Systems I | | |
| | **Instructor**<br>Prof. Dr.-Ing. Jutta Hanson | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-hs-1010-ue | **Course name**<br>Power Systems I | | |
| | **Instructor**<br>Prof. Dr.-Ing. Jutta Hanson | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Electrical Machines and Drives | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-bi-1020 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

| | |
|---|---|
| 1 | **Content**<br>Construction and function of induction machine, synchronous machine, direct current machine. Electromagnetic field within machines, armature windings, steady-state performance as motor/generator, application as line-fed and inverter-fed drives. Significance for electric power generation, both to the grid and in stand-alone version. |
| 2 | **Learning objectives / Learning Outcomes**<br>With active collaboration during lectures by asking questions related to those parts, which have not been completely understood by you, as well as by independent solving of examples ahead of the tutorial (not as late as during preparation for examination) you should be able to:<br>• calculate and explain the stationary operation performance of the three basic types of electric machine sin motor and generator mode,<br>• understand the application of electrical machines in modern drive systems and to design simple drive applications by yourself,<br>• understand and explain the function and physical background of the components of electrical machines<br>• understand and explain the impact of basic electromagnetic field and force theory on the basic function of electrical machines. |
| 3 | **Recommended prerequisite for participation**<br>Mathematics I to III, Electrical Engineering I and II, Physics, Mechanical Engineering |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc/MSc Wi-ETiT, BEd |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Detailed textbook and collection of exercices; Complete set of PowerPoint presentations<br>L.Matsch: Electromagnetic and electromechanical machines, Int.Textbook, 1972<br>A.Fitzgerald et al: Electric machinery, McGraw-Hill, 1971<br>S.Nasar et al: Electromechanics and electric machines, Wiley&Sons, 1995<br>R.Fischer: Elektrische Maschinen, C.Hanser-Verlag, 2004 |

**Courses**

| **Course Nr.**<br>18-bi-1020-vl | **Course name**<br>Electrical Machines and Drives | |
|---|---|---|
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | **Type**<br>Lecture | **SWS**<br>2 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-bi-1020-ue | Electrical Machines and Drives | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr. techn. Dr.h.c. Andreas Binder | | Practice | 2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Power Electronics | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-gt-1010 | 5 CP | 150 h | 90 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Gerd Griepentrog | | |

**1 Content**

Power electronic devices convert the energy from the distribution network to the form required by the load. This conversion does not wear out, can be controlled very fast and has a high efficiency. In lecture "Power Electronics" the most important circuits required for the energy conversion are treated, using ideal switches.
The main chapters are
I.) Line commutated converters in order to understand the basic concepts of power electronic systems.
II.) Self- commutated converters (one, two and four quadrant converters, 3-phase- VSI)

**2 Learning objectives / Learning Outcomes**

After an active participation in the lecture, as well as by solving all exercises prior to the respective tutorial students should be able to:

- Understand the ideal concept of power semiconductors
- Calculate and sketch the time-characteristics of all currents and voltages in a line-commutated converter using defined simplifications as well as represent the behavior of currents and voltages during commutation in line-commutated converters for center –tapped as well as for bridge circuits.
- Specify the basic circuit diagrams for one, two and four quadrant DC/DC converters and calculate the characteristics of voltages and currents in these circuits.
- Explain the function of single-phase and three-phase voltage source inverters and calculate the currents and voltages in these circuits using defined simplifications.
- Understannd the concept und operation of HVDC converter

**3 Recommended prerequisite for participation**

Mathe I und II, ETiT I und II, Energietechnik

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

MSc ETiT, MSc MEC, Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

Lecture notes, instructions for exercises are available for download in Moodle.
Literature:
Probst U.: „Leistungselektronik für Bachelors: Grundlagen und praktische Anwendungen", Carl Hanser Verlag GmbH & Co. KG, 2011
Jäger, R.: „Leistungselektronik: Grundlagen und Anwendungen", VDE-Verlag; Auflage 2011
Heumann, K.: „Grundlagen der Leistungselektronik"; Teubner; Stuttgart; 1985
Lappe, R.: „Leistungselektronik"; Springer-Verlag; 1988
Mohan, Undeland, Robbins: Power Electronics: Converters, Applications and Design; John Wiley Verlag; New York; 2003

| Courses | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-gt-1010-vl | **Course name**<br>Power Electronics | | |
| | **Instructor**<br>Prof. Dr.-Ing. Gerd Griepentrog | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-gt-1010-ue | **Course name**<br>Power Electronics | | |
| | **Instructor**<br>Prof. Dr.-Ing. Gerd Griepentrog, M.Sc. Milad Khani | | **Type**<br>Practice | **SWS**<br>2 |

### 3.3.3.3 EET - Proseminars (open catalogue)

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.**<br>18-bi-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

| | |
|---|---|
| **1** | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| **2** | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-bi-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hs-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Jutta Hanson | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-hs-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | | |
| | **Instructor**<br>Prof. Dr.-Ing. Jutta Hanson | | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hi-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Volker Hinrichsen | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.<br>Additional information can be found here. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 18-hi-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Volker Hinrichsen, M.Sc. Johannes Wiener | | Introductory Seminar Course | 2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-gt-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German and English | | | Prof. Dr.-Ing. Gerd Griepentrog | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-gt-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Gerd Griepentrog | | Introductory Seminar Course | 2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-st-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Florian Steinke | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology.<br>Additional information can be found here. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 18-st-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr. rer. nat. Florian Steinke, M.Sc. Christopher Thomas Peter Ripp | | Introductory Seminar Course | 2 |

## 3.4 Option Communication and Sensor Systems (KTS)

### 3.4.1 Fundamentals

#### 3.4.1.1 KTS - Mandatory Courses

| **Module name**<br>Fundamentals of Signal Processing | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-zo-1030 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Abdelhak Zoubir | | |

| | |
|---|---|
| 1 | **Content**<br>The course covers the following topics:<br>• The basic concepts of stochastic<br>• The sampling theorem<br>• Discrete-time noise processes and their properties<br>• Description of noise processes in the frequency domain<br>• Linear time-invariant systems: FIR and IIR filters<br>• Filtering of noise processes: AR, MA, and ARMA models<br>• The Matched filter<br>• The Wiener filter<br>• Properties of estimators<br>• The method of least squares |
| 2 | **Learning objectives / Learning Outcomes**<br>The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)<br>In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase. |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

Lecture notes and slides can be downloaded here:

- http://www.spg.tu-darmstadt.de
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River,1999.

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-vl | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Lecture | 3 |

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-ue | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Practice | 1 |

| **Module name**<br>Fundamentals of Communication | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-jk-1010 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| 1 | **Content**<br>Part 1: Chap. 1 will be a brief introduction in "Electrical Information- and Communication Engineering", presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.<br>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.<br>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.<br>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited inter-symbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture. |
| 2 | **Learning objectives / Learning Outcomes**<br>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.<br>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems. |
| 3 | **Recommended prerequisite for participation**<br>Deterministic Signals and Systems |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |

| | |
|---|---|
| 8 | **References**<br>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addision-Wesley 1992. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-jk-1010-vl | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-jk-1010-ue | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Communication Technology I | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-kl-1020 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Anja Klein | | |

| | |
|---|---|
| 1 | **Content**<br>Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of the lecture, students possess the ability to:<br>• classify signals and communication systems,<br>• understand, model and analyse basic components of communication systems,<br>• understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,<br>• model and analyse base-band commnication systems,<br>• describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,<br>• understand, model, evaluate, compare and apply linear modulation schemes,<br>• design receiver structures for different modulation schemes,<br>• detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,<br>• understand and model OFDM,<br>• understand and model CDMA,<br>• understand and compare the basic properties of multiple access schemes. |
| 3 | **Recommended prerequisite for participation**<br>Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Will be announced in the lecture |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.** | **Course name** | | |
| 18-kl-1020-vl | Communication Technology I | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Anja Klein | | Lecture | 3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-kl-1020-ue | Communication Technology I | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos | | Practice | 1 |

| **Module name** Microwave Engineering I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.** 18-jk-1020 | **Credit Points** 6 CP | **Workload** 180 h | **Self study** 120 h | **Duration** 1 | **Cycle offered** WiSe |
| **Language** German | | | **Module owner** Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| 1 | **Content**<br>Electromagnetic spectrum, kinds of transmission media, frequency ranges, bit rates, applications; Radio-Frequency (RF) and Microwave Circuits, Components and Modules, Passive RF Circuits with R-, L- and C-Lumped Elements: Resonant and Equivalent RLC Circuits, Graphical Representation of RF Circuits with the Smith Chart, Lumped-Element Impedance Matching; Theory and Applications of Transmission Lines: General Transmission-Line Equations, Lossless Transmission Lines as Circuit Elements, Line Terminations, Transmission-Line devices; Scattering-Matrix Formulation of N-Port RF Devices: Characterization of Microwave Networks, Concatenation of Two S-Matrixes, Applications of S-Parameters; Passive microwave components: waveguide splitter, circulator, directional coupler, filter, attenuator, matching network; Antennas: Antenna performance parameter, Ideal dipole with uniform current distribution, Antenna arrays of ideal dipoles, Image theory, Antenna modelling, Transmission Factor and Power Budget of Radio Links: Friis transmission equation, Gain and effective aperture of antennas, Radar equation, System noise temperature, Antenna noise temperature, Power budget of radio links, Basic propagation effects: reflection, transmission, scattering, diffraction; The radio channel: The two-ray propagation model, Doppler shift Multipath propagation, Stochastic behaviour of the mobile radio channel |
| 2 | **Learning objectives / Learning Outcomes** |
| 3 | **Recommended prerequisite for participation**<br>Nachrichtentechnik, Grundlagen der Technischen Elektrodynamik |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Script will be hand out; Literature will be recommended in first lecture |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-jk-1020-vl | Microwave Engineering I | | |
| **Instructor** Prof. Dr.-Ing. Rolf Jakoby | | **Type** Lecture | **SWS** 3 |
| **Course Nr.** | **Course name** | | |
| 18-jk-1020-ue | Microwave Engineering I | | |
| **Instructor** Prof. Dr.-Ing. Rolf Jakoby | | **Type** Practice | **SWS** 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Information Theory I | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-kp-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| English | | | Prof. Dr. techn. Heinz Köppl | | |

**1 Content**

This lecture course introduces the fundamentals of information and network information theory.
Outline:
information, uncertainty, entropy, mutual information, capacity, differential entropy, typical sequences, Gaussian channels, basics of source and channel coding, linear block codes, Shannon's source coding theorem, Shannon's channel coding theorem, capacity of Gaussian channels, capacity of bandlimited channels, Shannon's bound, bandwidth efficiency, capacity of multiple parallel channels and waterfilling, Gaussian vector channel, Multiple Access Channel, Broadcast Channel, rate region..

**2 Learning objectives / Learning Outcomes**

Students will understand the fundamentals of classic information theory.

**3 Recommended prerequisite for participation**

Knowledge of basic communication theory und probability theory

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc iST, MSc iCE, BSc Wi-ETiT, BSc/MSc CE

**7 Grade bonus compliant to §25 (2)**

**8 References**

1. T.M. Cover and J.A. Thomas, Elements of Information Theory, Wiley & Sons, 1991.
2. Abbas El Gamal and Young-Han Kim, Network Information Theory, Cambrige, 2011.
3. S. Haykin, Communication Systems, Wiley & Sons, 2001.

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-kp-1010-vl | Information Theory I | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. techn. Heinz Köppl, M.Sc. Anam Tahir | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-kp-1010-ue | Information Theory I | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. techn. Heinz Köppl, M.Sc. Anam Tahir | | Practice | 1 |

### 3.4.2 KTS - More Fundamentals

| **Module name**<br>General Computer Science II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0290 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Karsten Weihe | | |

| | |
|---|---|
| **1** | **Content**<br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |
| **2** | **Learning objectives / Learning Outcomes**<br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time |
| **3** | **Recommended prerequisite for participation**<br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers |
| **4** | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| **5** | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

| | |
|---|---|
| | Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009<br>ISBN-13: 978-3-8689-4001-5<br>Algorithmen in Java<br>Robert Sedgewick<br>Pearson Studium<br>3. überarbeitete Auflage, 2003<br>ISBN-13: 978-3-8273-7072-3<br>Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011<br>ISBN-13: 978-3-8689-4076-3 |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>20-00-0290-iv | **Course name**<br>General Computer Science II | | |
| **Instructor** | | **Type**<br>Integrated Course | **SWS**<br>4 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Analog Integrated Circuit Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1020 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog propierties of digital logic gates |
| 3 | **Recommended prerequisite for participation**<br>Lecture “Electronics” |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ho-1020-vl | Analog Integrated Circuit Design | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-ho-1020-ue | Analog Integrated Circuit Design | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann | | Practice | 1 |

| Module name<br>Electronics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1010 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

**1 Content**

Semiconductor Devices: Diode, MOSFET, Bipolar Transistor; Design of Electronic Circuits;
Analog Circuits: Basic Properties, Properties and Application of Operational Amplifiers, Circuit Simulation with SPICE, Small Signal Gain, Single Stage Amplifiers; Frequency Response;
Digital Circuits: CMOS Logic Circuits

**2 Learning objectives / Learning Outcomes**

A student is, after successful completion of this module, able to

- analyse Diodes, MOS- und Bipolartransistors in simple circuits
- calculate the properties of single transistor circuits, such as small signal gain, input and output resistance
- design inverting and non-inverting amplifiers from operational amplifiers and knows their ideal and non-ideal properties
- calculate the frequency behavior of simple transistor circuits
- distinguish the different methods to construct a logical gate from basic transistors and explain their fundamental properties.

**3 Recommended prerequisite for participation**

Basics of Electrical Engineering

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT,BSc iST, BEd

**7 Grade bonus compliant to §25 (2)**

A grade improvement of up to 1,0 due to a bonus is possible, which can be earned with tests.

**8 References**

Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design

**Courses**

| **Course Nr.**<br>18-ho-1011-vl | **Course name**<br>Electronics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | **Type**<br>Lecture | **SWS**<br>2 |

| **Course Nr.**<br>18-ho-1011-ue | **Course name**<br>Electronics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Electronics Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1030 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Lab experiments on:<br>• Digital Circuits: FPGA programming<br>• Analog Ciruits: Basic Components, Amplifiers, Operational Amplifiers, Filters and Demodulators |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to<br>• perform measurement on operational amplifier circuits in the time- and frequency domain using an oscilloscope<br>• design a traffic light controller using state diagrams and download the program to a FPGA, |
| 3 | **Recommended prerequisite for participation**<br>Basics of Electrical Engineering; Lecture “Electronics” which is running in parallel |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Duration: 60 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, WI-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Slide Copies of Lecture “Electronics”; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-ho-1011-pr | **Course name**<br>Electronics Lab | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Ferdinand Keil | | **Type**<br>Internship | **SWS**<br>2 |
| **Course Nr.**<br>18-ho-1030-ev | **Course name**<br>Electronics Lab - Introductory Meeting | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Introductory Course | **SWS**<br>0 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Electrical Power Engineering | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-bi-1010 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

**1 Content**

The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.
First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.
Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.
The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.

**2 Learning objectives / Learning Outcomes**

Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.
They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.
They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.
They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.

**3 Recommended prerequisite for participation**

Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

| | |
|---|---|
| 6 | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE |
| 7 | **Grade bonus compliant to §25 (2)**<br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades. |
| 8 | **References**<br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Renningen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.;Quaschning: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-bi-1010-vl | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-bi-1010-ue | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Introduction to Electrodynamics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-dg-1010 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Herbert De Gersem | | |

| | |
|---|---|
| 1 | **Content**<br>Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi conductor transmission lines (capacitance, inductance, and conductance matrix), velocity definitions, basics of rectangular waveguides. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space. They are able to recognice and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools. |
| 3 | **Recommended prerequisite for participation**<br>Lecture notes. Further literature recommendations are given in the course. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)**<br>Improvement by up to 0.4 due to bonus points which can be acquired by means of e-learning online tests. |
| 8 | **References**<br>Lecture notes. Further literature recommendations are given in the course. |

**Courses**

| **Course Nr.**<br>18-dg-1010-vl | **Course name**<br>Introduction to Electrodynamics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Lecture | **SWS**<br>2 |

| **Course Nr.**<br>18-dg-1010-ue | **Course name**<br>Introduction to Electrodynamics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Practice | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Microelectronic Devices | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-pr-1030 | 4 CP | 120 h | 75 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Sascha Preu | | |

**1 Content**

- Introduction: Semiconductor Devices & Microelectronic
- Semiconductor: Materials, Physics & Technology
- PN-Junction
- Metal-Oxide-Semiconductor Capacity
- Schottky Contact
- MOS-Field-Effect-Transistor (MOSFET)
- CMOS: Digital Applications
- MOS-Memory
- Bipolar- Junction-Transistor
- Outlook: Scaling Limits & SET,...

**2 Learning objectives / Learning Outcomes**

- Understand the physical properties and processes in semiconductor devices and materials
- the operation of basic semiconductor devices like diode, MOS-Transistor and bipolar transistor
- Understand functionality of basic circuits like rectifier circuit , 1-transistor amplifier and inverter from the device point of view.
- Goal: Understand state-of-the art semiconductor devices and circuits as a basis for a successful engineering career

**3 Recommended prerequisite for participation**

Electrical Engineering and Information Technology I, Electrical Engineering and Information Technology II, Laboratory ETiT, Laboratory Electronics, Mathematics I, Mathematics II, Physics

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

Skript: Microelectronic devices - the Basics

- Robert F. Pierret: Semiconductor Device Fundamentals, ISBN 0201543931
- Roger T. How, Charles G. Sodini: Microelectronics - an Integrated Approach, ISBN 0135885183
- Richard C. Jaeger: Microelectronic Circuit Design, ISBN 0071143866
- Y. Taur, T.H. Ning, Fundamentals of Modern VLSI Devices, ISBN 0521559596
- Thomas Tille, Doris Schmidt-Landsiedel: Mikroelektronik, ISBN 3540204229
- Michael Reisch: Halbleiter-Bauelemente, ISBN 3540213848

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-pr-1030-vl | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-pr-1030-ue | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Logic Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Boolean algebra, logic gates, hardware description languages, flipflops, sequential circuits, state-diagrams and -tables, technology mapping, programmable logic circuits |
| 2 | **Learning objectives / Learning Outcomes**<br>By this module, Students will be enabled to<br>• rewrite boolean expressions and transform them into circuits of logic gates<br>• analyze and synthesize digital circuits<br>• describe digital circuits in a hardware description language<br>• extract finite state machines from informal descriptions and implement them with synchronous circuits |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>R.H. Katz: Contemporary Logic Design |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-hb-1010-vl | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-hb-1010-ue | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1024 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0054-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0054-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1025 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0055-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0055-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Software Engineering - Introduction | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

| | |
|---|---|
| 1 | **Content**<br>The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engi-neering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of soft-ware architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).<br>During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of re-quirements, definition of a design and eventually the implementation of executable (proof-of-concept) code. |
| 2 | **Learning objectives / Learning Outcomes**<br>This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.<br>After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Further-more, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal. |
| 3 | **Recommended prerequisite for participation**<br>sound knowledge of an object-oriented programming language (preferably Java) |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc iST, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>www.es.tu-darmstadt.de/lehre/se-i-v/ |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-su-1010-vl | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-su-1010-ue | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche | | Practice | 1 |

| Module name<br>Software Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

**1 Content**

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**2 Learning objectives / Learning Outcomes**

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**3 Recommended prerequisite for participation**

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/sp/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-st-1020-pr | Software Lab | | |
| **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Internship | **SWS**<br>3 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Technical Mechanics for Electrical Engineering | | | | | |
| **Module Nr.**<br>16-26-6400 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Tobias Melz | | |

**1 Content**

Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.
Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.
Kinematics: point and rigid body movement.
Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact.

**2 Learning objectives / Learning Outcomes**

In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

**7 Grade bonus compliant to §25 (2)**

**8 References**

Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4
Exercises are embodied in the book.
Further reading:
Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6
Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2
Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1
Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).
Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt.

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 16-26-6400-vl | Technical Mechanics for Electrical Engineering | | |
| **Instructor** | | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 16-26-6400-ue | Technical Mechanics for Electrical Engineering | | |
| | **Instructor** | | **Type** | **SWS** |
| | | | Practice | 2 |

### 3.4.3 KTS - Specialization

#### 3.4.3.1 KTS - Lectures (open catalogue)

| **Module name**<br>Computational Methods for Systems and Synthetic Biology | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kp-2080 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr. techn. Heinz Köppl | | |

**1 Content**

The course covers mathematical methods used in the area of systems and synthetic biology. On the one hand it deals with practical modeling of molecular processes but also with theoretical investigations that reveal general properties of those processes. The course follows a microscopic approach and introduces those processes using probabilistic methods. For that, necessary prerequists are recapitulated, such as definition of Markov processes in different spaces and their properties. With this background, the dynamics of stochastic reaction kinetics in terms of population models is investigated. Limiting cases are introduced, such as the diffusion approximation or the deterministic approximation (fluid approximations) of those systems. Often methods from statistical physics are applied. Numerical methods for solving the corresponding Fokker-Planck and Master equations are discussed. For the limiting case of a deterministic approximation, traditional methods for the stability analysis of nonlinear differential equations are introduced and methods are discussed that just rely on the topology of the reaction network to determine stability properties. In this context, a derivation of the moment dynamics and approximation methods based on moment closure are given. Connections to queueing theory models are shown.
Furthermore, the question is addressed of how the introduced dynamical models are calibrated to data from molecular biology. For that, general methods of statistical inference from statistics and of machine learning from computer science are discussed and specialized algorithms for the considered system class are presented. Additionally, a short introduction to the theory of nonlinear optimal filtering is given and special cases such as hidden Markov models are discussed.
Beyond reaction kinetics, the course provides a basic introduction to the modeling and numerical methods used in molecular dynamics. Newtonian multi-body simulations and classical potentials and their use in molecular dynamics are discussed. Most of the topics in this course are introduced through practical examples from applied modeling in the domain of systems biology. The applicability of the respective methods in synthetic biology is highlighted.

**2 Learning objectives / Learning Outcomes**

Students that successfully passed that course should be able to perform practical modeling of molecular processes and to determine dynamical properties of model using mathematical methods. It relies on the understanding of the following topics:

- Mathematical abstraction of molecular mechanisms
- General properties of stochastic processes
- Approximation methods for Markovian population models
- Stability analysis of nonlinear differential equations
- Numerical methods for solving/simulating stochastic systemsSystem identification/machine learning for stochastic systems

**3 Recommended prerequisite for participation**

Basic knowledge of programming, Matlab.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Optional, Standard Grading System)

**5 Grading**

| | | | | |
|---|---|---|---|---|
| | Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) | | | |
| **6** | **Usability of this module**<br>MSc ETiT, MSc iST, MSc Wi-ETiT, MSc MEC | | | |
| **7** | **Grade bonus compliant to §25 (2)** | | | |
| **8** | **References**<br>http://www.bcs.tu-darmstadt.de/ | | | |
| **Courses** | | | | |
| | **Course Nr.**<br>18-kp-2080-vl | **Course name**<br>Computational Methods for Systems and Synthetic Biology | | |
| | **Instructor**<br>Prof. Dr. techn. Heinz Köppl | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-kp-2080-ue | **Course name**<br>Computational Methods for Systems and Synthetic Biology | | |
| | **Instructor**<br>Prof. Dr. techn. Heinz Köppl | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Communication Networks II | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-sm-2010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| English | | | Prof. Dr.-Ing. Ralf Steinmetz | | |

**1 Content**

The course Communication Networks II covers the principles and practice of computer networking and telecommunications with emphasis on the Internet. Starting with the history, the course discusses past, current and future aspects of communication networks. In addition to the basics including well known protocols and technologies, recent developments in the area of multimedia communication (e.g., Video Streaming, P2P, IP-Telephony, Cloud Computing and Service-oriented Architectures) will be examined thoroughly. The course is designed as follow-up to Communication Networks I.

Topics are:

- Basics and History of Communication Networks (Telegraphy vs. Telephony, Reference Models, ...)
- Transport Layer (Addressing, Flow Control, Connection Management, Error Detection, Congestion Control, ...)
- Transport Protocols (TCP, SCTP)
- Interactive Protocols (Telnet, SSH, FTP, ...)
- Electronic Mail (SMTP, POP3, IMAP, MIME, ...)
- World Wide Web (HTML, URL, HTTP, DNS, ...)
- Distributed Programming (RPC, Web Services, Event-based Communication)
- SOA (WSDL, SOAP, REST, UDDI, ...)
- Cloud Computing (SaaS, PaaS, IaaS, Virtualization, ...)
- Overlay Networks (Unstructured P2P, DHT Systems, Application Layer Multicast, ...)
- Video Streaming (HTTP Streaming, Flash Streaming, RTP/RTSP, P2P Streaming, ...)
- VoIP and Instant Messaging (SIP, H.323)

**2 Learning objectives / Learning Outcomes**

The course Communication Networks II covers the principles and practice of computer networking and telecommunications with emphasis on the Internet. Starting with the history, the course discusses past, current and future aspects of communication networks. In addition to the basics including well known protocols and technologies, recent developments in the area of multimedia communication (e.g., Video Streaming, P2P, IP-Telephony, Cloud Computing and Service-oriented Architectures) will be examined thoroughly. The course is designed as follow-up to Communication Networks I.

**3 Recommended prerequisite for participation**

Basic courses of first 4 semesters are required. Knowledge in the topics covered by the course Communication Networks I is recommended. Theoretical knowledge obtained in the course Communication Networks II will be strengthened in practical programming exercises. So, basic programming skills are beneficial.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

MSc ETiT, MSc iST, Wi-ETiT, CS, Wi-CS

**7 Grade bonus compliant to §25 (2)**

**8 References**

Selected chapters from following books:

- Andrew S. Tanenbaum: Computer Networks, Fourth 5th Edition, Prentice Hall, 2010
- James F. Kurose, Keith Ross: Computer Networking: A Top-Down Approach, 6th Edition, Addison-Wesley, 2009
- Larry Peterson, Bruce Davie: Computer Networks, 5th Edition, Elsevier Science, 2011

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-sm-2010-vl | Communication Networks II | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ralf Steinmetz, M.Sc. Philipp Achenbach, M.Sc. Tobias Meuser, M.Sc. Christoph Gärtner | | Lecture | 3 |

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-sm-2010-ue | Communication Networks II | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ralf Steinmetz, M.Sc. Philipp Achenbach, M.Sc. Tobias Meuser, M.Sc. Christoph Gärtner | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Convex Optimization in Signal Processing and Communications | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-pe-2020 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| English | | | Prof. Dr.-Ing. Marius Pesavento | | |

| | |
|---|---|
| 1 | **Content**<br>This graduate course introduces the basic theory of convex optimization and illustrates its use with many recent applications in communication systems and signal processing.<br>Outline: Introduction, convex sets and convex functions, convex problems and classes of convex problems (LP, QP, SOCP, SDP, GP), Lagrange duality and KKT conditions, basics of numerical algorithms and interior point methods, optimization tools, convex inner and outer approximations for non convex problems, sparse optimization, distributed optimization, mixted integer linear and non-linear programming, applications. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will learn the basic theory of convex optimization and its applications. |
| 3 | **Recommended prerequisite for participation**<br>Knowledge in linear algebra and the basic concepts of signal processing and communications. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)<br>The examination takes place in form of a written exam (duration: 120 minutes). If one can estimate that less than 14 students register, the examination will be an oral examination (duration: 20 min.). The type of examination will be announced in the beginning of the lecture. |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>MSc ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004. (online Verfügbar: http://www.stanford.edu/~boyd/cvxbook/)<br>2. D. P. Bertsekas, Nonlinear Programming, Athena Scientific, Belmont, Massachusetts, 2nd Ed., 1999.<br>3. Daniel P. Palomar and Yonina C. Eldar, Convex Optimization in Signal Processing and Communications, Cambridge University Press, 2009. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-pe-2020-vl | **Course name**<br>Convex Optimization in Signal Processing and Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Marius Pesavento | | **Type**<br>Lecture | **SWS**<br>2 |
| **Course Nr.**<br>18-pe-2020-ue | **Course name**<br>Convex Optimization in Signal Processing and Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Marius Pesavento | | **Type**<br>Practice | **SWS**<br>1 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-pe-2020-pr | Convex Optimization in Signal Processing and Communications Lab | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Marius Pesavento | | Internship | 1 |

| **Module name**<br>Antennas and Adaptive Beamforming | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-jk-2020 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| 1 | **Content**<br>Overview of most important antenna parameters types as well as their applications. Fundamental theories: Fourier transform for far-field pattern calculations, antenna modeling techniques, antenna synthesis methods, image theory, determination of field regions of line sources, of the average radiated power density and power, directivity and gain. Antennas as key elements in power budgets of radio links, introducing the effective aperture of an antenna, deriving the relation between gain and effective aperture. Array antennas are a key hardware for beamforming and smart antenna systems: fundamentals of phased-scanning arrays, non-uniformly excited, equally spaced linear arrays, multi-dimensional planar arrays and mutual coupling effects. Wire antennas: still the most prevalent of all antenna forms, relatively simple in concept, easy to construct, very inexpensive. Antenna radiation fields and antenna parameters for different types of antennas are derived from Maxwell´s equations, applied for aperture antennas (horns, lenses or reflector antennas) and printed antennas (microstrip-patch and coplanar-slot antennas) Some basic numerical calculation methods: integral equation methods in the time and frequency domain, physical optics and uniform theory of diffraction are briefly summarized and compared for antennas and scattering problems. Smart antennas in communication and radar systems, with focus on beam steering and adaptive beamforming. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will know basic antenna parameters: pattern, gain, directivity, half-power beamwidth, side- lobe-level, efficiency and input impedance to compare, assess and evaluate different antennas for various applications and operating frequencies. The antenna field regions, reactive near-field, near-field and far-field, can be differentiated and the far-field pattern of an antenna can be determined from given current distributions along the antenna by using Fourier transformation or integral solutions with distributed ideal dipoles as basic elements (antenna analysis). To assess in general physical requirements, constrains and limitations of antennas, students can use fundamental antenna theory: impedance matching techniques, antenna modeling and far-field pattern analysis, antenna synthesis, image theory and fundamental limits of electrically small antennas. After being incorporated into the different adaptive beamforming techniques, the array theory enables the student to design antenna systems that are assembled of a certain number of separate elements, feeding network, beamforming network etc. for phased-scanning or smart antennas in communications and sensing. Moreover, students are able to determine, analyze and evaluate the most important classes of antennas in wireless technology for many applications, operating frequencies, desired requirements or practical constrains: (1.) wire- dipole antennas, (2.) planar antennas (microstrip, dipole and slot antennas), (3.) aperture antennas (horn antennas, parabolic reflector antennas, lens antennas, Cassegrain and Gregorian double-reflector configurations), (4.) broadband and frequency-independent antennas (V antennas, biconical antennas, helical antennas, spiral and log-periodic antennas). |
| 3 | **Recommended prerequisite for participation**<br>Fundamentals of Communications, Microwave Engineering 1 |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, MSc ETiT, MSc iCE, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |

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|---|---|---|---|---|
| | | | | |
| **8** | **References**<br>Jakoby, Skriptum Antennas and Adaptive Beamforming, wird am Beginn der Vorlesung verkauft und kann danach im FG-Sekretariat erworben werden | | | |
| **Courses** | | | | |
| | **Course Nr.**<br>18-jk-2020-vl | **Course name**<br>Antennas and Adaptive Beamforming | | |
| | **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby, M.Sc. Matthias Nickel | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-jk-2020-ue | **Course name**<br>Antennas and Adaptive Beamforming | | |
| | **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby, M.Sc. Matthias Nickel | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Machine Learning in Information and Communication Technology (ICT) | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kp-2110 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr. techn. Heinz Köppl | | |

**1 Content**

The module provides an introduction to the emerging field of machine learning from an engineering perspective. Important models and learning methods are presented and exemplified through problems from information and communication technology.

- Fundamentals of probability theory and multivariate statistics
- Taxonomy of machine learning problems and models (supervised, unsupervised, generative, discriminative)
- Regression and classification: theory, methods and ICT applications
- Dimensionality reduction, clustering and big data analytics: methods and application in communications and signal processing
- Probabilistic graphical models: categories, inference and parameter estimation
- Fundamentals of Bayesian inference, Monte Carlo methods, Bayesian non-parametrics
- Fundamentals of convex optimization: Solution methods and application in communications
- Approximate algorithms for scalable Bayesian inference; application in signal processing and information theory (e.g. decoding of LDPC codes)
- Hidden Markov models (HMM): Theory, Algorithms and ICT applications (e.g. Viterbi decoding of convolutional codes)
- High-dimensional statistics (“large p small n” setting), learning dependency structure in high-dimensional data, learning causality relations from observational data.
- Sparse estimation, random projections, compressive sensing: Theory and applications in signal processing
- Deep neural networks (deep learning): Models, learning algorithms, libraries and ICT applications

**2 Learning objectives / Learning Outcomes**

Students are able to interpret and categorize specific engineering problems from the ICT domain in terms of machine learning problems.
They are able to reduce such problems to standard machine learning problems and are able to determine suitable solution methods for them.
They are able to implement all necessary algorithms from scratch, but they are also familiar with the state-of-the-art libraries in machine learning.
They are able to determine the involved computational complexity of a method and choose an appropriate solution algorithms based on application constraints.
They are able to apply the acquired methods to other domains, such as data analysis in biomedical engineering, analysis of social network data, etc.

**3 Recommended prerequisite for participation**

Good command of Matlab (for instance knowledge from course 18-st-2030 Matlab Grundkurs) and engineering mathematics

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Optional, Weighting: 100 %)

**6 Usability of this module**

MSc etit, BSc/MSc iST, MSc iCE, MSc CE

| | |
|---|---|
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>• Kevin P. Murphy. Machine Learning – A probabilistic perspective, MIT Press, 2012<br>• Christopher M. Bishop. Pattern recognition and Machine Learning, Springer, 2006<br>• Peter Bühlmann und Sara van de Geer. Statistics of high-dimensional data – Methods, theory and applications, Springer, 2011 |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-kp-2110-vl | **Course name**<br>Machine Learning in Information and Communication Technology (ICT) | | |
| **Instructor**<br>Prof. Dr. techn. Heinz Köppl, Prof. Dr.-Ing. Anja Klein | | **Type**<br>Lecture | **SWS**<br>2 |
| **Course Nr.**<br>18-kp-2110-pr | **Course name**<br>Machine Learning in Information and Communication Technology (ICT) Lab | | |
| **Instructor**<br>Prof. Dr. techn. Heinz Köppl, Prof. Dr.-Ing. Anja Klein | | **Type**<br>Internship | **SWS**<br>1 |
| **Course Nr.**<br>18-kp-2110-ue | **Course name**<br>Machine Learning in Information and Communication Technology (ICT) | | |
| **Instructor**<br>Prof. Dr. techn. Heinz Köppl, Prof. Dr.-Ing. Anja Klein | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Matrix Analysis and Computations | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pe-2070 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr.-Ing. Marius Pesavento | | |

| | |
|---|---|
| 1 | **Content**<br>This graduate course is a foundation class on matrix analysis and computations, which are widely used in many different fields, e.g., machine learning, computer vision, systems and control, signal and image processing, communications, networks, optimization, and many more...<br>Apart from the theory this course will also cover the design of efficient algorithm and it considers many different examples from the aforementioned fields including examples from social media and big data analysis, image processing and medical imaging, communication network optimization, and written text classification.<br>Specific topics: (i) basic matrix concepts, subspace, norms, (ii) linear least squares (iii) eigendecomposition, singular value decomposition, positive semidenite matrices, (iv) linear system of equations, LU decomposition, Cholesky decomposition (v) pseudo-inverse, QR decomposition (vi) advanced tensor decomposition, advanced matrix calculus, compressive sensing, structured matrix factorization |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will learn matrix analysis and computations at an advanced or research level. |
| 3 | **Recommended prerequisite for participation**<br>Basic knowledge in linear algebra. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| 6 | **Usability of this module** |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>1.Gene H. Golub and Charles F. van Loan, Matrix Computations (Fourth Edition), John Hopkins University Press, 2013.<br>2.Roger A. Horn and Charles R. Johnson, Matrix Analysis (Second Edition), Cambridge University Press, 2012.<br>3.Jan R. Magnus and Heinz Neudecker, Matrix Differential Calculus with Applications in Statistics and Econometrics (Third Edition), John Wiley and Sons, New York, 2007.<br>4.Giuseppe Calaore and Laurent El Ghaoui, Optimization Models, Cambridge University Press, 2014.<br>ECE 712 Course Notes by Prof. Jim Reilly, McMaster University, Canada (friendly notes for engineers) http://www.ece.mcmaster.ca/faculty/reilly/ece712/course_notes.htm |

**Courses**

| **Course Nr.**<br>18-pe-2070-vl | **Course name**<br>Matrix Analysis and Computations | |
|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Marius Pesavento | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-pe-2070-ue | Matrix Analysis and Computations | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Marius Pesavento | | Practice | 1 |

| **Module name**<br>Radar Techniques | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-jk-2040 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| **1** | **Content**<br>First, there will be an introduction of different radar techniques, describing their concepts and principles, their applications and the operating frequency ranges. In a historical survey, the radar ranges and propagation effects will be dealt with. In the second part, various primary and secondary radar techniques will be investigated in detail, including specific techniques of radar signal processing and -analysis. |
| **2** | **Learning objectives / Learning Outcomes**<br>Students will know about concepts and principles to detect objects as well as to determine the angular position and range of objects. They learn about the functional principles of various radar systems, including signal processing. They will understand the major physical propagation effects. |
| **3** | **Recommended prerequisite for participation**<br>Fundamentals of Communications, Microwave Engineering I |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Oral Examination, Duration: 30 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Oral Examination, Weighting: 100 %) |
| **6** | **Usability of this module**<br>MSc ETiT, MSc iCE, MSc Wi-ETiT |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References**<br>Slides, Latest Publications and Books |

**Courses**

| **Course Nr.**<br>18-jk-2040-vl | **Course name**<br>Radar Techniques | | |
|---|---|---|---|
| **Instructor**<br>PD Dr. habil. Holger Maune | | **Type**<br>Lecture | **SWS**<br>2 |

| **Module name**<br>Sensor Array Processing and Adaptive Beamforming | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pe-2060 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr.-Ing. Marius Pesavento | | |

**1 Content**

This lecture course introduces the principles of modern sensor array processing and adaptive beamforming.
Outline: Motivation and background; applications, narrowband and wideband signal model
Direction-of-arrival estimation (DoA):
traditional methods based on beamforming, super resolution methods, Maximum-Likelihood methods, Subspace based methods, MUSIC, ESPRIT, MODE, root-MUSIC, multidimensional source localization, beamspace processing, array interpolation, partly calibrated arrays, wideband DOA estimation, spatial smoothing, forward-backward averaging, redundancy averaging, correlated sources, minimum redundancy arrays, compressed sensing and sparse reconstruction based DoA estimation, performance bounds
Adaptive beamforming:
Point-source model, covariance model, Wiener-Hopf equation, Minimum Variance Distortionless Response (MVDR) beamformer, Capon Beamformer, sample matrix inversion, signal self-nulling effect, robust adaptive beamforming, Hung-Turner projection beamformer, Generalized Sidelobe canceller beamformer, Eigenspace-based beamformer, non-stationary environments, modern convex optimization based beamforming, worst-case based beamforming, multiuser beamforming.

**2 Learning objectives / Learning Outcomes**

Students will standard and modern sensor array processing techniques for source localization and transmit/receive beamforming

**3 Recommended prerequisite for participation**

Knowledge in linear algebra.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc / MSc etit, BSc / MSc WI-etit, MSc MEC, MSc iST, MSc iCE

**7 Grade bonus compliant to §25 (2)**

**8 References**

- Academic Press Library in Signal Processing: Volume 3 Array and Statistical Signal Processing Edited by Rama Chellappa and Sergios Theodoridis, Section 2, Edited by Mats Viberg, Pages 457-967 (2014)
  - Chapter 12 - Adaptive and Robust Beamforming, Sergiy A. Vorobyov, Pages 503-552
  - Chapter 14 - DOA Estimation Methods and Algorithms, Pei-Jung Chung, Mats Viberg, Jia Yu, Pages 599-650
  - Chapter 15 - Subspace Methods and Exploitation of Special Array Structures, Martin Haardt, Marius Pesavento, Florian Roemer, Mohammed Nabil El Korso, Pages 651-717

- Spectral Analysis of Signals, Petre Stoica, Randolph Moses, Prentice Hall, April 2005Optimum Array Processing: Part IV of Detection, Estimation, and Modulation Theory, Harry L. Van Trees, Wiley Online, 2002.

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-pe-2060-vl | **Course name**<br>Sensor Array Processing and Adaptive Beamforming | | |
| | **Instructor**<br>Prof. Dr.-Ing. Marius Pesavento | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-pe-2060-ue | **Course name**<br>Sensor Array Processing and Adaptive Beamforming | | |
| | **Instructor**<br>Prof. Dr.-Ing. Marius Pesavento | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Deterministic Signals and Systems | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-kl-1010 | 7 CP | 210 h | 135 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Anja Klein | | |

| | |
|---|---|
| 1 | **Content**<br>Fourier Series: Motivation; Fourier series with real coefficients; Fourier series with complex coefficients;examples and applications<br>Fourier Transform: Motivation - Derviation from Fourier series - Dirichlet conditions - delta function - step function - properties of F-transform - special cases - examples and applications - transmissions systems-expansion into partial fractions<br>Convolution: Time invariant systems - convolution in frequency domain- Parseval's theorem - properties-examples and applications<br>Systems and Signals: Bandlimited and time limited systems - systems with only one energy store - examples and applications<br>Laplace Transform: Motivation - single sided L-transform - inverse L-transform - theorems of L- transform - examples and applications<br>Linear differential equations: Time invariant systems - rules - general differentiation - linear passive electrical networks - equivalent circuits for passive electrical elements - examples and applications<br>z-Transform: motivation - sampling - numerical order - definition - examples - transfer function - sampling theorem - examples and applications<br>Discrete Fourier Transform: motivation, derivation sampling, examples and applications |
| 2 | **Learning objectives / Learning Outcomes**<br>The student should understand the principles of integral transformations. He should apply them for the solution of physical problems. The techniques of this lecture are essential tools which will be needed in many follow-up lectures and exercises. |
| 3 | **Recommended prerequisite for participation**<br>Elektrotechnik und Informationstechnik I und Elektrotechnik und Informationstechnik II |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT, LA Physik/Mathematik, BSc CE, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

A script of the lecture or slides respectively, will be provided in electronic form.
Basic Literature:
Wolfgang Preuss, “Funktionaltransformationen”, Carl Hanser Verlag, 2002; Klaus-Eberhard Krueger "Transformationen", Vieweg Verlag, 2002;
H. Clausert, G. Wiesemann "Grundgebiete der Elektrotechnik 2", Oldenbourg, 1993; Otto Föllinger "Laplace-, Fourier- und z-Transformation", Hüthig, 2003;
T. Frey, M. Bossert, Signal- und Systemtheorie, Teubner Verlag, 2004
Further Literature:
Dieter Mueller-Wichards "Transformationen und Signale", Teubner Verlag, 1999
Exercises:
Hwei Hsu "Signals and Systems", Schaum’s Outlines, 1995

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-kl-1010-vl | Deterministic Signals and Systems | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento | | Lecture | 3 |

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-kl-1010-ue | Deterministic Signals and Systems | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Anja Klein, Prof. Dr.-Ing. Marius Pesavento | | Practice | 2 |

| **Module name**<br>Bioinformatics I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kp-1020 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. techn. Heinz Köppl | | |

**1 Content**

- Biomolecular foundations of high-throughput measurement techniques (Microarrays, RNA-Seq, genome sequencing, proteinarrays, mass-spectrometry, flow-cytometry, mass-cytometry, genomics, proteomics, metabolomics)
- Foundations of statistics and machine learning (decision theory, regression, classification and clustering)
- Exact substring search, dynamic programming, algorithms for sequence comparison (PAM, BLAST, BLAST2, etc), alignment of multiple sequences (ClustalW, DAlign, etc)
- Important databases in bioinformatics and their use in medicine and biology (GenBank, Gene Expression Omnibus, Rfam, UniProt, Pfam, KEGG, BRENDA, Pathway Commons)
- Analysis of interaction networks (modularity, graph partitioning, spanning trees, differential network analysis, network motifs, STRING database, PathBLAST)
- Introduction to structural biology, structure prediction for RNA and proteins, Protein Data Bank (PDB)

**2 Learning objectives / Learning Outcomes**

After successful completion students are aware of frequently used high-throughput methods in molecular biology and are familiar with the resulting data format. They know the most important bioinformatics databases and acquired the necessary background to understand standard bioinformatics algorithms and to implement them from scratch in R or Matlab. Students are familiar with the basics of structural analysis and with structure prediction. With respect to communication skills, students learned to exchange informatio, ideas, problems and solutions related to bioinformatics with experts and with lay persons.

**3 Recommended prerequisite for participation**

Recommended is „General Computer Science I“

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc Biomedical Engineering

**7 Grade bonus compliant to §25 (2)**

**8 References**

**Courses**

| **Course Nr.**<br>18-kp-1020-vl | **Course name**<br>Bioinformatics I | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr. techn. Heinz Köppl | | **Type**<br>Lecture | **SWS**<br>2 |

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Project Seminar Emerging topics in MIMO Communication Networks | | | | | |
| **Module Nr.**<br>18-pe-2050 | **Credit Points**<br>8 CP | **Workload**<br>240 h | **Self study**<br>180 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>English | | | **Module owner**<br>Prof. Dr.-Ing. Marius Pesavento | | |
| **1** | **Content**<br>This project-seminar addresses new trends in MIMO communications for the next generation of wireless communication systems.<br>The specific thematic focus of the seminar will be adapted from year to year according to the latest trends in wireless communications. The topics will be announced on the course website well in advance. | | | | |
| **2** | **Learning objectives / Learning Outcomes**<br>Students will learn the fundamental concepts, procedures, theories, algorithms and applications of Massive MIMO systems and 5 G mobile communication networks by the latest scientific publications. | | | | |
| **3** | **Recommended prerequisite for participation** | | | | |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Oral Examination, Duration: 40 min, Standard Grading System) | | | | |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Oral Examination, Weighting: 100 %) | | | | |
| **6** | **Usability of this module**<br>MSc ETiT, MSc Wi-ETiT, MSc iCE | | | | |
| **7** | **Grade bonus compliant to §25 (2)** | | | | |
| **8** | **References**<br>References include the latest scientific publications, seminars and books. | | | | |
| **Courses** | | | | | |
| | **Course Nr.**<br>18-pe-2050-pj | **Course name**<br>Project Seminar Emerging Topics in MIMO Communication Networks | | | |
| | **Instructor**<br>Prof. Dr.-Ing. Marius Pesavento | | | **Type**<br>Project Seminar | **SWS**<br>4 |

| **Module name**<br>Project Seminar Communication and Sensor Systems | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kl-1041 | **Credit Points**<br>8 CP | **Workload**<br>240 h | **Self study**<br>180 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

| | |
|---|---|
| 1 | **Content**<br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of the course, students possess:<br>• the ability to apply methods of communication and sensor systems to practical problems<br>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks<br>• the skills to find, analyze and evaluate scientific reference papers for a particular topic<br>• the capability to summarize the achieved scientific findings in the form of a concise report<br>• the ability to present and discuss achieved results in the form of a presentation in front of an audience |
| 3 | **Recommended prerequisite for participation**<br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Will be announced in the lecture |

**Courses**

| **Course Nr.**<br>18-kl-1041-pj | **Course name**<br>Project Seminar Communication and Sensor Systems | |
|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Anja Klein, M.Sc. Sumedh Dongare | **Type**<br>Project Seminar | **SWS**<br>4 |

| **Module name**<br>Project Seminar Communication and Sensor Systems | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kp-1041 | **Credit Points**<br>8 CP | **Workload**<br>240 h | **Self study**<br>180 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr. techn. Heinz Köppl | | |

| | |
|---|---|
| **1** | **Content**<br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. |
| **2** | **Learning objectives / Learning Outcomes**<br>After completion of the course, students possess:<br>• the ability to apply methods of communication and sensor systems to practical problems<br>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks<br>• the skills to find, analyze and evaluate scientific reference papers for a particular topic<br>• the capability to summarize the achieved scientific findings in the form of a concise report<br>• the ability to present and discuss achieved results in the form of a presentation in front of an audience |
| **3** | **Recommended prerequisite for participation**<br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References**<br>Will be announced in the lecture |

**Courses**

| | **Course Nr.**<br>18-kp-1041-pj | **Course name**<br>Project Seminar Communication and Sensor Systems | | |
|---|---|---|---|---|
| | **Instructor**<br>Prof. Dr. techn. Heinz Köppl | | **Type**<br>Project Seminar | **SWS**<br>4 |

| **Module name**<br>Project Seminar Communication and Sensor Systems | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pe-1041 | **Credit Points**<br>8 CP | **Workload**<br>240 h | **Self study**<br>180 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr.-Ing. Marius Pesavento | | |

| | |
|---|---|
| 1 | **Content**<br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of the course, students possess:<br>• the ability to apply methods of communication and sensor systems to practical problems<br>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks<br>• the skills to find, analyze and evaluate scientific reference papers for a particular topic<br>• the capability to summarize the achieved scientific findings in the form of a concise report<br>• the ability to present and discuss achieved results in the form of a presentation in front of an audience |
| 3 | **Recommended prerequisite for participation**<br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Will be announced in the lecture |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-pe-1041-pj | Project Seminar Communication and Sensor Systems | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Marius Pesavento, M.Sc. Yufan Fan | | Project Seminar | 4 |

| **Module name**<br>Project Seminar Communication and Sensor Systems | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-zo-1041 | **Credit Points**<br>8 CP | **Workload**<br>240 h | **Self study**<br>180 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr.-Ing. Abdelhak Zoubir | | |

| | |
|---|---|
| 1 | **Content**<br>Investigating and solving specific problems concerning communication and sensor systems (Problems concerning communications engineering, microwave technology, signal processing, sensor networks etc. are possible, topics will be defined out of the recent research topics of the involved labs), working on a a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications for a given task, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of the course, students possess:<br>• the ability to apply methods of communication and sensor systems to practical problems<br>• deep and special knowledge in a particular field of communication and sensor systems (communications engineering), RF technology, signal processing, sensor networks<br>• the skills to find, analyze and evaluate scientific reference papers for a particular topic<br>• the capability to summarize the achieved scientific findings in the form of a concise report<br>• the ability to present and discuss achieved results in the form of a presentation in front of an audience |
| 3 | **Recommended prerequisite for participation**<br>Previous knowledge in chosen discipline, e.g. communication technology, signal processing, microwave technology, sensor networks |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Will be announced in the lecture |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-zo-1041-pj | **Course name**<br>Project Seminar Communication and Sensor Systems | | |
| | **Instructor**<br>Prof. Dr.-Ing. Abdelhak Zoubir | | **Type**<br>Project Seminar | **SWS**<br>4 |

| **Module name**<br>Project Seminar Communication and Sensor Systems | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pr-1041 | **Credit Points**<br>8 CP | **Workload**<br>240 h | **Self study**<br>180 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr. rer. nat. Sascha Preu | | |

| | |
|---|---|
| 1 | **Content**<br>Investigating and solving specific problems concerning the development of Terahertz sensors and -systems as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.:<br>• Optics on chip<br>• Semiconductor devicesLight-matter interaction |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of the course, students possess:<br>• the ability to apply theoretical models to practical problems<br>• deep and special knowledge in a particular field related to THz science, optics or semiconductor physics<br>• the skills to find, analyze and evaluate scientific reference papers for a particular topic<br>• the capability to summarize the achieved scientific findings in the form of a concise reportthe ability to present and discuss achieved results in the form of a presentation in front of an audience |
| 3 | **Recommended prerequisite for participation**<br>Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, BSc CE, BSc iST, BSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Will be announced once the topic is defined. |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-pr-1041-pj | Project Seminar Communication and Sensor Systems | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Sascha Preu | | Project Seminar | 4 |

| **Module name**<br>Project Seminar Terahertz Systems & Applications | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pr-1020 | **Credit Points**<br>9 CP | **Workload**<br>270 h | **Self study**<br>210 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr. rer. nat. Sascha Preu | | |

**1 Content**

Investigating and solving specific problems concerning the development of Terahertz devices and systems as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.:

- Optics on chip
- Semiconductor devicesLight-matter interaction

**2 Learning objectives / Learning Outcomes**

After completion of the course, students possess:

- the ability to apply theoretical models to practical problems
- deep and special knowledge in a particular field related to THz science, optics or semiconductor physics
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise reportthe ability to present and discuss achieved results in the form of a presentation in front of an audience

**3 Recommended prerequisite for participation**

Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc/MSc iST

**7 Grade bonus compliant to §25 (2)**

**8 References**

Will be announced once the topic is defined

**Courses**

| **Course Nr.**<br>18-pr-1020-pj | **Course name**<br>Project Seminar Terahertz Systems & Applications | |
|---|---|---|
| **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | **Type**<br>Project Seminar | **SWS**<br>4 |

### 3.4.3.3 KTS - Proseminars (open catalogue)

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.**<br>18-kl-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

| | |
|---|---|
| **1** | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| **2** | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| **3** | **Recommended prerequisite for participation**<br>Basic knowledge from the first four semesters |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-kl-1000-ps | Proseminar Electrical Engineering and Information Technology | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Anja Klein, M.Sc. Sumedh Dongare | | Introductory Seminar Course | 2 |

| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kp-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. techn. Heinz Köppl | | |

| | |
|---|---|
| **1** | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| **2** | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| **Course Nr.**<br>18-kp-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | |
|---|---|---|
| **Instructor**<br>Prof. Dr. techn. Heinz Köppl | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-pe-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Marius Pesavento | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-pe-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | | |
| **Instructor**<br>Prof. Dr.-Ing. Marius Pesavento, M.Sc. Wassim Suleiman | | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-zo-1000 | 2 CP | 60 h | 30 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Abdelhak Zoubir | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-zo-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | | |
| **Instructor**<br>Prof. Dr.-Ing. Abdelhak Zoubir | | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pr-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Sascha Preu | | |

| | |
|---|---|
| **1** | **Content**<br>Literature seminar: Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. Interested students please directly contact Prof. Sascha Preu for definition of a topic: sascha.preu@tu-darmstadt.de<br>Link to TSYS-website. |
| **2** | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| **Course Nr.**<br>18-pr-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | |
|---|---|---|
| **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

## 3.5 Option Sensors, Actuators and Electronics (SAE)

### 3.5.1 SAE - Fundamentals

#### 3.5.1.1 SAE - Mandatory Courses

| **Module name** Product Development Methodology I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.** 18-kn-1025 | **Credit Points** 5 CP | **Workload** 150 h | **Self study** 105 h | **Duration** 1 | **Cycle offered** WiSe |
| **Language** German | | | **Module owner** Prof. Dr. Mario Kupnik | | |

| | |
|---|---|
| **1** | **Content**<br>Practical experience in the methods used for the development of technical products. Work in a project team. |
| **2** | **Learning objectives / Learning Outcomes**<br>Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such aspart lists, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect. |
| **3** | **Recommended prerequisite for participation**<br>Parallel attendance of Proseminar ETiT Option MPE |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References**<br>Script: Development Methodology (PEM) |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-kn-1025-pj | Product Development Methodology I | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. Mario Kupnik, Prof. Dr.-Ing. Khanh Quoc Tran, Prof. Dr.-Ing. Klaus Hofmann, Prof. Ph.D. Thomas Peter Burg | | Project Seminar | 3 |

| **Module name**<br>Measuring Technique | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kn-1011 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Mario Kupnik | | |

**1 Content**

The module includes theoretical discussion and practical application of the measuring chain in detail on example the electrical variables (current, voltage, impedance, power) and selected non-electrical variables (frequency, time, force, pressure and acceleration).
In the lecture the following chapter will be thematically treated measuring signals and measuring equipment (oscilloscope, laboratory testing equipment), static measurement error and disturbance variables (especially temperature), basic measurement circuits, AD conversion principles and filtering, measurement method non-electrical variables and the statistics of measurements (distributions, statist safe tests).
The topics of the lecture are discussed in the exercise of the module. Examples are analyzed and their application in measurement scenarios are practiced.
The practicum of the module consists of five experiments which are time closely matched in time to the lecture:

- Measuring of signals in the time range with digital storage oscilloscope, trigger conditions
- Measuring of signals in the frequency range with digital storage oscilloscope, error of measurement (aliasing / subsampling, leackage) and window functions
- Measuring of mechanical dimensions with suitable primary sensors, sensor electronics / amplifier circuits
- computer-based measuring
- Importing of sensor signals, whose processing and the resulting automated control of a process using a programmable logic controller (PLC)

**2 Learning objectives / Learning Outcomes**

The students know the structure of the measuring chain and the specific properties of the corresponding elements. They know the structure of electronic measuring instruments and basic measuring circuits for electrical and selected non-electrical variables and can apply them. They know the basics of capturing, processing, transferring and storage of measurement data and can describe error sources and quantifying their influences.
In the practicum, the students deepen the basis of the measurements with the oscilloscope, the understanding of the relationship between time and frequency range. Methodically they are able to document and evaluate the data during laboratory measuring.

**3 Recommended prerequisite for participation**

Basics of ETiT I-III, Math I-III, Electronic

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Standard BWS)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 4)

Module Eccompanying Examination:

- [18-kn-1011-pr] (Study Achievement, Optional, Weighting: 2)

| | | | | |
|---|---|---|---|---|
| **6** | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, BSc MEC | | | |
| **7** | **Grade bonus compliant to §25 (2)** | | | |
| **8** | **References**<br>• Slide set of lecture<br>• Textbook and exercise book Lerch: „Elektrische Messtechnik“, Springer<br>• Exercise documents<br>• Practical experiment manuals | | | |
| **Courses** | | | | |
| | **Course Nr.**<br>18-kn-1011-vl | **Course name**<br>Measuring Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1011-pr | **Course name**<br>Measuring Technique Lab | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Internship | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1011-ue | **Course name**<br>Measuring Technique | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Electronics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1010 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

**1 Content**

Semiconductor Devices: Diode, MOSFET, Bipolar Transistor; Design of Electronic Circuits;
Analog Circuits: Basic Properties, Properties and Application of Operational Amplifiers, Circuit Simulation with SPICE, Small Signal Gain, Single Stage Amplifiers; Frequency Response;
Digital Circuits: CMOS Logic Circuits

**2 Learning objectives / Learning Outcomes**

A student is, after successful completion of this module, able to

- analyse Diodes, MOS- und Bipolartransistors in simple circuits
- calculate the properties of single transistor circuits, such as small signal gain, input and output resistance
- design inverting and non-inverting amplifiers from operational amplifiers and knows their ideal and non-ideal properties
- calculate the frequency behavior of simple transistor circuits
- distinguish the different methods to construct a logical gate from basic transistors and explain their fundamental properties.

**3 Recommended prerequisite for participation**

Basics of Electrical Engineering

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT,BSc iST, BEd

**7 Grade bonus compliant to §25 (2)**

A grade improvement of up to 1,0 due to a bonus is possible, which can be earned with tests.

**8 References**

Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design

**Courses**

| **Course Nr.**<br>18-ho-1011-vl | **Course name**<br>Electronics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | **Type**<br>Lecture | **SWS**<br>2 |

| **Course Nr.**<br>18-ho-1011-ue | **Course name**<br>Electronics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Oliver Bachmann | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| System Dynamics and Automatic Control Systems I | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ko-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Ulrich Konigorski | | |

**1 Content**

Description and classification of dynamic systems; Linearization around an equilibrium point; Stability of dynamic systems; Frequency response; Linear time-invariant closed-loop systems; Controller design; Control structure optimization

**2 Learning objectives / Learning Outcomes**

Students will know how to describe and classify different dynamic systems. They will be able to analyse the dynamic behaviour in time and frequency domain. The students will be able to design controllers for linear time invariant systems.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc MEC, MSc Informatik

**7 Grade bonus compliant to §25 (2)**

**8 References**

Skript Konigorski: “Systemdynamik und Regelungstechnik I”, Aufgabensammlung zur Vorlesung, Lunze: "Regelungstechnik 1: Systemtheoretische Grundlagen, Analyse und Entwurf einschleifiger Regelungen",
Föllinger: "Regelungstechnik: Einführung in die Methoden und ihre Anwendungen",
Unbehauen: "Regelungstechnik I:Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme, Fuzzy-Regelsysteme", Föllinger: "Laplace-, Fourier- und z-Transformation",
Jörgl: "Repetitorium Regelungstechnik",
Merz, Jaschke: "Grundkurs der Regelungstechnik: Einführung in die praktischen und theoretischen Methoden",
Horn, Dourdoumas: "Rechnergestützter Entwurf zeitkontinuierlicher und zeitdiskreter Regelkreise",
Schneider: "Regelungstechnik für Maschinenbauer",
Weinmann: "Regelungen. Analyse und technischer Entwurf: Band 1: Systemtechnik linearer und linearisierter Regelungen auf anwendungsnaher Grundlage"

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ko-1010-vl | System Dynamics and Automatic Control Systems I | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-ko-1010-tt | System Dynamics and Automatic Control Systems I- Auditorium Exercise | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Ulrich Konigorski, M.Sc. Florian Hermann Weigand | | Tutorial | 1 |

### 3.5.2 SAE - More Fundamentals

| **Module name**<br>General Computer Science II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0290 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Karsten Weihe | | |

| | |
|---|---|
| **1** | **Content**<br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |
| **2** | **Learning objectives / Learning Outcomes**<br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time |
| **3** | **Recommended prerequisite for participation**<br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers |
| **4** | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| **5** | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009
ISBN-13: 978-3-8689-4001-5
Algorithmen in Java
Robert Sedgewick
Pearson Studium
3. überarbeitete Auflage, 2003
ISBN-13: 978-3-8273-7072-3
Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011
ISBN-13: 978-3-8689-4076-3

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 20-00-0290-iv | General Computer Science II | | |
| **Instructor** | | **Type** | **SWS** |
| | | Integrated Course | 4 |

| **Module name**<br>Analog Integrated Circuit Design | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1020 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Basic analog Building Blocks: Current Mirrors, Reference Circuits; Multi Stage Amplifier, internal Structure and Properties of Differential and Operational Amplifiers, Feedback Techniques, Frequency Response, Oscillators |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to 1. derive the fundamental properties of the MOS-Transistors from knowledge of the layout or fabrication process, 2. derive fundamental MOSFET-circuits (current source, current mirror, switch, active resistors, inverting amplifiers, differential amplifiers, output amplifiers, operational amplifiers, comparators) and knows their fundamental properties (y-Parameters, DC- and AC-properties), 3. understands simulation methods for analog circuits on transistor level using SPICE, 4. analyse feedback amplifiers regarding frequency gain, stability, bandwidth, root locus, amplitude and phase-margin, 5. derive and calculate the analog propierties of digital logic gates |
| 3 | **Recommended prerequisite for participation**<br>Lecture “Electronics” |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT, MSc iCE, BSc/MSc iST, BSc/MSc MEC, MSc EPE |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Lecture Slide Copies; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| **Course Nr.**<br>18-ho-1020-vl | **Course name**<br>Analog Integrated Circuit Design | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Lecture | **SWS**<br>3 |

| **Course Nr.**<br>18-ho-1020-ue | **Course name**<br>Analog Integrated Circuit Design | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Electronics Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1030 | **Credit Points**<br>3 CP | **Workload**<br>90 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Lab experiments on:<br>• Digital Circuits: FPGA programming<br>• Analog Ciruits: Basic Components, Amplifiers, Operational Amplifiers, Filters and Demodulators |
| 2 | **Learning objectives / Learning Outcomes**<br>A student is, after successful completion of this module, able to<br>• perform measurement on operational amplifier circuits in the time- and frequency domain using an oscilloscope<br>• design a traffic light controller using state diagrams and download the program to a FPGA, |
| 3 | **Recommended prerequisite for participation**<br>Basics of Electrical Engineering; Lecture “Electronics” which is running in parallel |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Duration: 60 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, WI-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Slide Copies of Lecture “Electronics”; Richard Jaeger: Microelectronic Circuit Design |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-ho-1011-pr | **Course name**<br>Electronics Lab | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann, M.Sc. Ferdinand Keil | | **Type**<br>Internship | **SWS**<br>2 |
| **Course Nr.**<br>18-ho-1030-ev | **Course name**<br>Electronics Lab - Introductory Meeting | | |
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | | **Type**<br>Introductory Course | **SWS**<br>0 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Electrical Power Engineering | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-bi-1010 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. techn. Dr.h.c. Andreas Binder | | |

**1 Content**

The lecture gives an introduction to the technical processes for the use of energy for the human civilization in general and to the basic tasks and challenges of the electrical energy in particular. Biochemical energy processes such as the human metabolism are therefore not subject of the course.

First, the physical basics of the term “energy” are repeated and the different forms of energy (mechanical, thermal, electromagnetic, chemical and nuclear) are explained in terms of the technical use of energy as heat, mechanical movement and electricity.

Then, an overview of the energy resources is given, starting from the solar radiation and its direct and indirect impact, such as the solar heat and the motion of air mass, surface water and sea waves. Next, the energy source of biomass due to solar radiation and the fossil energy sources oil, natural gas and coal will be discussed. The energy sources of nuclear fission (uranium deposits) and nuclear fusion (heavy water), and geothermal energy due to nuclear effects in the Earth’s interior are explained as well as the tidal effects caused by planetary motion. The increasing energy demand of the rapidly growing world population and the geographic distribution of energy sources (deposits, acreage, solar radiation, wind maps, tidal currents, ...) are described.

The resulting energy flows on transport routes such as pipelines, waterways, ..., are briefly presented. In another section, energy conversion processes (direct and indirect methods) are illustrated. Large-scale processes such as thermal cycles or hydraulic processes in power plants are discussed mainly, but also marginal processes such as thermionic converters are addressed. Afterwards, a specialization takes place on the subject of electric power supply with respect to the increasing proportion of the electric power applications. The chain from the electric generator to the consumer with an overview of the required resources, the hiring electrical load flow and its stability is addressed. The storage of energy and in particular of electrical energy by converting into other forms of energy will be discussed. Finally, questions for the contemporary use of energy resources in regard to sustainability are mentioned.

**2 Learning objectives / Learning Outcomes**

Students know the physically based energy basics and have an overview of the energy resources of our planet Earth.

They understand the fundamental energy conversion processes on the technical use of energy in the form of heat as well as mechanical and electrical work.

They have acquired basic knowledge of electrical engineering in the chain of effects from electric power producer to the consumer and are able to educate themselves about current issues of energy use and its future development.

They are able to perform basic calculations for energy content, energy conversion, efficiencies, storage, and for conversion and transportation losses. They are prepared for advanced lectures on energy components and systems, energy industry, and on future forms of energy supply.

**3 Recommended prerequisite for participation**

Basic knowledge of physics (mechanics, thermodynamics, electrical engineering, structure of matter) and chemistry (binding energy) are desirable and facilitate understanding of the energetic processes.

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

| | |
|---|---|
| **6** | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT, BSc MEC, BSc iST, BSc CE, MSc ESE |
| **7** | **Grade bonus compliant to §25 (2)**<br>At the beginning of the semester, it will be announced whether there will be homework tests accompanying the lecture that will enable an improvement in grades. |
| **8** | **References**<br>Lecture notes (slides)<br>Practice documents (examples, solutions)<br>Additional and more detailed literature:<br>Grothe/Feldhusen: Dubbel-Taschenbuch für den Maschinenbau, Springer, Berlin, 2007, 22. Aufl.; besonders: Kapitel „Energietechnik und Wirtschaft“; Sterner/Stadler: Energiespeicher – Bedarf, Technologien, Integration, Springer-Vieweg, Berlin, 2011; Rummich: Energiespeicher, expert-verlag, Renningen, 2015, 2. Aufl.; Strauß: Kraftwerkstechnik zur Nutzung fossiler, nuklearer und regenerativer Energiequellen, Springer, Berlin, 2006, 5. Aufl.; Hau: Windkraftanlagen –Grundlagen, Technik, Einsatz, Wirtschaftlichkeit, Springer-Vieweg, Berlin, 2014, 5. Aufl.; Heuck/Dettmann/Schulz: Elektrische Energieversorgung, Springer-Vieweg, Berlin, 2014, 9. Aufl.;Quaschning: Regenerative Energiesystem, Hanser, München, 2001, 7. Aufl. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-bi-1010-vl | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-bi-1010-ue | **Course name**<br>Electrical Power Engineering | | |
| **Instructor**<br>Prof. Dr. techn. Dr.h.c. Andreas Binder | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Introduction to Electrodynamics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-dg-1010 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Herbert De Gersem | | |

| | |
|---|---|
| 1 | **Content**<br>Vector calculus, orthogonal coordinate systems, Maxwell's equations, interface and boundary conditions, layered media, electrostatics, scalar potential, Coulomb integral, separation of variables, method of image charges, magnetostatics, vector potential, Biot-Savart law, stationary current fields, fields in matter, energy flow, skin effect, plane waves, polarization, TEM waves, reflection and multi-layer problems, multi conductor transmission lines (capacitance, inductance, and conductance matrix), velocity definitions, basics of rectangular waveguides. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students will be familiar with Maxwell's equations in integral and differential form for static and dynamic field problems. They will have a mental picture of wave phenomena in free space. They are able to recognice and interpret wave effects in the different areas of electrical engineering. They are able to derive the wave effects from Maxwell's equations and have a good understanding of the necessary mathematical tools. |
| 3 | **Recommended prerequisite for participation**<br>Lecture notes. Further literature recommendations are given in the course. |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)**<br>Improvement by up to 0.4 due to bonus points which can be acquired by means of e-learning online tests. |
| 8 | **References**<br>Lecture notes. Further literature recommendations are given in the course. |

**Courses**

| **Course Nr.**<br>18-dg-1010-vl | **Course name**<br>Introduction to Electrodynamics | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Lecture | **SWS**<br>2 |
| **Course Nr.**<br>18-dg-1010-ue | **Course name**<br>Introduction to Electrodynamics | | |
| **Instructor**<br>Prof. Dr.-Ing. Herbert De Gersem | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Fundamentals of Signal Processing | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-zo-1030 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Abdelhak Zoubir | | |

**1 Content**

The course covers the following topics:

- The basic concepts of stochastic
- The sampling theorem
- Discrete-time noise processes and their properties
- Description of noise processes in the frequency domain
- Linear time-invariant systems: FIR and IIR filters
- Filtering of noise processes: AR, MA, and ARMA models
- The Matched filter
- The Wiener filter
- Properties of estimators
- The method of least squares

**2 Learning objectives / Learning Outcomes**

The course covers basic concepts of signal processing, and illustrates them with practical examples. It serves as an introductory course for advanced lectures in digital signal processing, adaptive filtering, communications, and control theory.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Duration: 120 min, Standard Grading System)

In general, the examination takes place in form of a written exam (duration: 120 minutes). If up to 10 students register in semesters in which the lecture does not take place, there will will be an oral examination (duration: 30 min.). The type of examination will be announced within one working week after the end of the examination registration phase.

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written/Oral Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc MEC

**7 Grade bonus compliant to §25 (2)**

**8 References**

Lecture notes and slides can be downloaded here:

- http://www.spg.tu-darmstadt.de
- Moodle platform

Further reading:

- A. Papoulis: Probability, Random Variables and Stochastic Processes. McGraw-Hill, Inc., third edition, 1991.
- P. Z. Peebles, Jr.: Probability, Random Variables and Random Signal Principles. McGraw-Hill, Inc., fourth edition, 2001.
- E. Hänsler: Statistische Signale; Grundlagen und Anwendungen. Springer Verlag, 3. Auflage, 2001.
- J. F. Böhme: Stochastische Signale. Teubner Studienbücher, 1998.
- A. Oppenheim, W. Schafer: Discrete-time Signal Processing. Prentice Hall Upper Saddle River,1999.

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-zo-1030-vl | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-zo-1030-ue | Fundamentals of Signal Processing | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Abdelhak Zoubir | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Microelectronic Devices | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-pr-1030 | 4 CP | 120 h | 75 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Sascha Preu | | |

**1 Content**

- Introduction: Semiconductor Devices & Microelectronic
- Semiconductor: Materials, Physics & Technology
- PN-Junction
- Metal-Oxide-Semiconductor Capacity
- Schottky Contact
- MOS-Field-Effect-Transistor (MOSFET)
- CMOS: Digital Applications
- MOS-Memory
- Bipolar- Junction-Transistor
- Outlook: Scaling Limits & SET,...

**2 Learning objectives / Learning Outcomes**

- Understand the physical properties and processes in semiconductor devices and materials
- the operation of basic semiconductor devices like diode, MOS-Transistor and bipolar transistor
- Understand functionality of basic circuits like rectifier circuit , 1-transistor amplifier and inverter from the device point of view.
- Goal: Understand state-of-the art semiconductor devices and circuits as a basis for a successful engineering career

**3 Recommended prerequisite for participation**

Electrical Engineering and Information Technology I, Electrical Engineering and Information Technology II, Laboratory ETiT, Laboratory Electronics, Mathematics I, Mathematics II, Physics

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

Skript: Microelectronic devices - the Basics

- Robert F. Pierret: Semiconductor Device Fundamentals, ISBN 0201543931
- Roger T. How, Charles G. Sodini: Microelectronics - an Integrated Approach, ISBN 0135885183
- Richard C. Jaeger: Microelectronic Circuit Design, ISBN 0071143866
- Y. Taur, T.H. Ning, Fundamentals of Modern VLSI Devices, ISBN 0521559596
- Thomas Tille, Doris Schmidt-Landsiedel: Mikroelektronik, ISBN 3540204229
- Michael Reisch: Halbleiter-Bauelemente, ISBN 3540213848

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-pr-1030-vl | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-pr-1030-ue | **Course name**<br>Microelectronic Devices | | |
| | **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | | **Type**<br>Practice | **SWS**<br>1 |

| **Module name**<br>Communication Technology I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kl-1020 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Anja Klein | | |

**1 Content**

Signals and Communication Systems, Base-band Communications, Detection of Base-band Signals in AWGN Channels, Bandpass-Signals und -Systems, Linear Digital Modulation Schemes, Digital Modulation und Detection, Multi-carier Transmission, OFDM, Spread-Spectrum Techniques, CDMA, Multiple Access

**2 Learning objectives / Learning Outcomes**

After completion of the lecture, students possess the ability to:

- classify signals and communication systems,
- understand, model and analyse basic components of communication systems,
- understand, evaluate and compare communication systems for transmission over additive white Gaussian noise channels,
- model and analyse base-band commnication systems,
- describe and analyse bandpass signals and bandpass communication systems in the equivalent base-band,
- understand, model, evaluate, compare and apply linear modulation schemes,
- design receiver structures for different modulation schemes,
- detect linear modulated data after transmission over additive white Gaussian noise channels in an optimum way,
- understand and model OFDM,
- understand and model CDMA,
- understand and compare the basic properties of multiple access schemes.

**3 Recommended prerequisite for participation**

Electrical Engineering I and II, Deterministische Signale und Systeme, Mathematics I to IV

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc CE, MSc iST, BSc MEC

**7 Grade bonus compliant to §25 (2)**

**8 References**

Will be announced in the lecture

**Courses**

| **Course Nr.**<br>18-kl-1020-vl | **Course name**<br>Communication Technology I | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Anja Klein | | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 18-kl-1020-ue | Communication Technology I | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Anja Klein, Dr. rer. nat. Sabrina Klos | | Practice | 1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Logic Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-hb-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Christian Hochberger | | |

| | |
|---|---|
| 1 | **Content**<br>Boolean algebra, logic gates, hardware description languages, flipflops, sequential circuits, state-diagrams and -tables, technology mapping, programmable logic circuits |
| 2 | **Learning objectives / Learning Outcomes**<br>By this module, Students will be enabled to<br>• rewrite boolean expressions and transform them into circuits of logic gates<br>• analyze and synthesize digital circuits<br>• describe digital circuits in a hardware description language<br>• extract finite state machines from informal descriptions and implement them with synchronous circuits |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>R.H. Katz: Contemporary Logic Design |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-hb-1010-vl | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-hb-1010-ue | **Course name**<br>Logic Design | | |
| | **Instructor**<br>Prof. Dr.-Ing. Christian Hochberger, M.Sc. Alexander Bernhard Schwarz | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Fundamentals of Communication | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-jk-1010 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Rolf Jakoby | | |

| | |
|---|---|
| 1 | **Content**<br>Part 1: Chap. 1 will be a brief introduction in "Electrical Information- and Communication Engineering", presenting signals as carrier of information, classifying electrical signals and describing elements of communication systems. Then, Chap. 2 introduces various line-conducted and wireless transmission media, power budget calculations for both media types, basics of antenna radiation and parameters etc., which will be emphasized by application examples like TV-satellite reception and mobile communication channels.<br>Part 2: Chap. 3 is focused on signal distortions and interferences, especially thermal noise, considering noisy two-port devices and its concatenations, lossy networks, antenna noise temperature and the impact of noise on analog and digital signals. This chap. ends with basics of information theory and channel capacity for AWGN-channels. In contrast, chap 4 deals with noise-reduction and distortion-compensation methods.<br>Part 3: Chap. 5 introduces sampling of band-limited signals and analog modulation of a pulse carrier (pulse-amplitude- pulse-duration- and pulse-angle-modulation), which will be extended on digital modulation in the baseband by means of pulse-code modulation (PCM), focusing on signal quantizing, analog-digital conversion, minimum bandwidth, bit error rate and error probability of a PCM word. At least, PCM-time-division multiplex and –systems will be discussed.<br>Part 4: Chap. 7 deals with fundamentals of multiplex- and RF-modulation schemes as well as with frequency conversion, frequency multiplication and mixing strategies. Then, receiver principles and image frequency problems of heterodyne-receivers as well as amplitude modulation of a sinus carrier will close this chapter. Chap. 8 introduces digital modulation of a harmonic carrier, including band-limited inter-symbol interference-free transmission, matched filtering and binary shift keying of a sinusoidal carrier in amplitude (ASK), phase (PSK) or frequency (FSK). From this follows higher-order modulation schemes like M-PSK or M-QAM. A brief outlook on the functionality of channel coding and interleaving in chap. 9 will end up the lecture. |
| 2 | **Learning objectives / Learning Outcomes**<br>Aim of the Lecture: To teach the fundamentals of communications (physical layer), primarily the transmission of signals from a source to a sink, possible modulation and access methods as well as signal distortion and noise.<br>The introduction of communications is a basement for further lectures like Communication Technology, Laboratories of Communication Technology (NTP A, B), Microwave Eng., Optical Communications, Mobile Communications and Terrestrial and satellite-based radio systems. |
| 3 | **Recommended prerequisite for participation**<br>Deterministic Signals and Systems |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |

| | |
|---|---|
| 8 | **References**<br>Complete Script and Literature: Pehl, E.: Digitale und analoge Nachrichtenübertragung, Hüthig, 1998; Meyer, Martin: Kommunikationstechnik, Vieweg, 1999; Stanski, B.: Kommunikationstechnik; Kammeyer, K.D.: Nachrichtenübertragung. B.G. Teubner 1996; Mäusl, R.: Digitale Modulationsverfahren. Hüthig Verlag 1995; Haykin, S.: Communication Systems. John Wiley 1994; Proakis, J., Salehi M.: Communication Systems Engineering. Prentice Hall 1994; Ziemer, R., Peterson, R.: Digital Communication. Prentice Hall 2001; Cheng, D.: Field and Wave Electromagnetics, Addision-Wesley 1992. |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-jk-1010-vl | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Lecture | **SWS**<br>3 |
| **Course Nr.**<br>18-jk-1010-ue | **Course name**<br>Fundamentals of Communications | | |
| **Instructor**<br>Prof. Dr.-Ing. Rolf Jakoby | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1024 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

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|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0054-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0054-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>Physics II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>05-91-1025 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Joachim Enders | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>05-11-0055-vl | **Course name** | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>05-13-0055-ue | **Course name** | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>1 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Software Engineering - Introduction | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1010 | 6 CP | 180 h | 120 h | 1 | WiSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

| | |
|---|---|
| 1 | **Content**<br>The lecture gives an introduction to the broad discipline of software engineering. All major topics of the field - as entitled e.g. by the IEEE's "Guide to the Software Engi-neering Body of Knowledge" - get addressed in the indicated depth. Main emphasis is laid upon requirements elicitation techniques (software analysis) and the design of soft-ware architectures (software design). UML (2.0) is introduced and used throughout the course as the favored modeling language. This requires the attendees to have a sound knowledge of at least one object-oriented programming language (preferably Java).<br>During the exercises, a running example (embedded software in a technical gadget or device) is utilized and a team-based elaboration of the tasks is encouraged. Exercises cover tasks like the elicitation of re-quirements, definition of a design and eventually the implementation of executable (proof-of-concept) code. |
| 2 | **Learning objectives / Learning Outcomes**<br>This lecture aims to introduce basic software engineering techniques - with recourse to a set of best-practice approaches from the engineering of software systems - in a practice-oriented style and with the help of one running example.<br>After attending the lecture students should be able to uncover, collect and document essential requirements with respect to a software system in a systematic manner using a model-driven/centric approach. Further-more, at the end of the course a variety of means to acquiring insight into a software system's design (architecture) should be at the student's disposal. |
| 3 | **Recommended prerequisite for participation**<br>sound knowledge of an object-oriented programming language (preferably Java) |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Duration: 90 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Written Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc iST, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>www.es.tu-darmstadt.de/lehre/se-i-v/ |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-su-1010-vl | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-su-1010-ue | Software Engineering - Introduction | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr, M.Sc. Lars Fritsche | | Practice | 1 |

| Module name<br>Software Lab | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-st-1020 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Florian Steinke | | |

**1 Content**

The lab covers the following basic software development skills:

- working together and software development in teams
- lightweight software engineering process eXtreme Programming (XP)
- training of advanced OO/Java programming skills and coding standards
- software documentation using JavaDoc
- the basics of the development tool eclipse
- regression testing methods (test framework JUnit) to increase software quality
- more sophisticated data structures and algorithms

**2 Learning objectives / Learning Outcomes**

Students participating in the lab deepen their basic programming knowledge (acquired in Computer Science for Engineers). The focus is on development of “medium-size” software in contrast to programming small toy examples, working in teams and evolution of existing software (framework). Afterwards students are expected to be able to develop small software systems using a "light-weight" software development process. Furthermore, they will appreciate training in more sophisticated software engineering techniques needed for the development of "real-world" software systems.

**3 Recommended prerequisite for participation**

Basics in Java (as taught in Introduction to Computer Science for Engineers).
Windows-Account of the ETiT PC-Pool

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT

**7 Grade bonus compliant to §25 (2)**

**8 References**

www.es.tu-darmstadt.de/lehre/sp/

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-st-1020-pr | Software Lab | | |
| **Instructor**<br>Prof. Dr. rer. nat. Florian Steinke | | **Type**<br>Internship | **SWS**<br>3 |

| Module name<br>Technical Mechanics for Electrical Engineering | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>16-26-6400 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Tobias Melz | | |

**1 Content**

Statics: force, moment (torque), free body diagram, equilibrium equations, center of gravity, truss, beams, adhesion and friction.
Mechanics of elastic bodies: stress and deformation, tension, torsion, bending.
Kinematics: point and rigid body movement.
Kinetics: dynamic force and moment equilibrium equations, energy and work, linear oscillators, momentum and angular momentum conservation laws, impact.

**2 Learning objectives / Learning Outcomes**

In this course the students will learn the basic concepts of technical mechanics. They should be able to analyze the statics of simple statically determinate planar systems, to carry out elementary elastomechanical calculations of statically determinate and statically indeterminate structures, to describe and analyze movements, and to solve planar motion problems, oscillation and shock phenomena with the laws of kinetics.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

**7 Grade bonus compliant to §25 (2)**

**8 References**

Markert, Norrick: Einführung in die Technische Mechanik, ISBN 978-3-8440-3228-4
Exercises are embodied in the book.
Further reading:
Markert: Statik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3279-6
Markert: Elastomechanik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-3280-2
Markert: Dynamik – Aufgaben, Übungs- und Prüfungsaufgaben mit Lösungen, ISBN 978-3-8440-2200-1
Gross, Hauger, Schröder, Wall: Technische Mechanik 1 - 3. Springer-Verlag Berlin (2012-2014).
Hagedorn: Technische Mechanik, Band 1 - 3. Verlag Harri Deutsch Frankfurt.

**Courses**

| **Course Nr.**<br>16-26-6400-vl | **Course name**<br>Technical Mechanics for Electrical Engineering | | |
|---|---|---|---|
| **Instructor** | | **Type**<br>Lecture | **SWS**<br>3 |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 16-26-6400-ue | Technical Mechanics for Electrical Engineering | | |
| | **Instructor** | | **Type** | **SWS** |
| | | | Practice | 2 |

### 3.5.3.1 SAE - Lectures, Labs, and Excursions (open catalogue)

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Excursion SAE | | | | | |
| **Module Nr.**<br>18-kn-1060 | **Credit Points**<br>1 CP | **Workload**<br>30 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Mario Kupnik | | |

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|---|---|
| 1 | **Content**<br>During the excursion SAE (duration 5 days) several companies working on electrical engineering and information technology and other fields will be visited. Students can become acquainted with close-to-reality examples. Working fields of an electrical engineer can be assessed, with technical- or organizational aspects and conditions of work as the main target. By the attendance of several companies in successive days, a comparison becomes possible. During the excursion the group is accommodated in e.g. hostels. |
| 2 | **Learning objectives / Learning Outcomes**<br>Students should be able to understand products and the associated production processes and be able to concisely summarize this in a report. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Pass/Fail Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 18-kn-1060-ek | Excursion SAE | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. Mario Kupnik, Prof. Dr.-Ing. Khanh Quoc Tran, Prof. Dr.-Ing. Klaus Hofmann, Prof. Ph.D. Thomas Peter Burg | | Field Trip | 0 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Product Development Methodology II | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1025 | 5 CP | 150 h | 105 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Practical experiences by using methodical procedures in the development of technical products. In addition teamwork, verbal and written representation of results and the organization of development. Work in a project team and organize the development process independently. |
| 2 | **Learning objectives / Learning Outcomes**<br>Applying the development methodology to a specific development project in a team. To do this, students can create a schedule, can analyze the state of the art, can compose a list of requirements, can abstract the task, can work out the sub-problems, can seek solutions with different methods, can work out optimal solutions using valuation methods, can set up a final concept, can derive the parameters needed by computation and modeling, can create the production documentation with all necessary documents such as bills of materials, technical drawings and circuit diagrams, can build up and investigate a laboratory prototype and can reflect their development in retrospect. |
| 3 | **Recommended prerequisite for participation**<br>Product Development Methodology I |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT, MSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Script: Development Methodology (PEM) |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ho-1025-pj | Product Development Methodology II | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Klaus Hofmann, Prof. Dr.-Ing. Khanh Quoc Tran, Prof. Dr. Mario Kupnik, Prof. Ph.D. Thomas Peter Burg | | Project Seminar | 3 |

| **Module name**<br>Electromechanical Systems I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kn-1050 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Mario Kupnik | | |

| | |
|---|---|
| 1 | **Content**<br>Structure and design methods of elektromechanical systems, mechanical, acoustical and thermal networks, transducers between mechanical and acoustical networks. Design and devices of electromechanical transducers. |
| 2 | **Learning objectives / Learning Outcomes**<br>Comprehension, description, calculation and application of the most relevant electromechanical transducers, comprising electrostatic transducer (e.g. microphone and accelerometer), piezoelectric transducers (e.g micro motors, micro sensors), electrodynamic transducer (loudspeaker, shaker), piezomagnetic transducer (e.g. ultrasonic source). Design of complex electromechanical systems like sensors and actuators and their applications by applying the discrete element network method. |
| 3 | **Recommended prerequisite for participation**<br>Electrical Engineering and Information Technology I |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc WI-ETiT, MSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Book: Electromechanical Systems in Microtechnic und Mechatronic, Springer 2012, Script for lecture Electromechanical Systems I, Workbook |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-kn-1050-vl | **Course name**<br>Electromechanical Systems I | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik, Prof. Dr. techn. Dr.h.c. Andreas Binder, M.Sc. Omar Ben Dali | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-kn-1050-ue | **Course name**<br>Electromechanical Systems I | | |
| | **Instructor**<br>Prof. Dr. Mario Kupnik, Prof. Dr. techn. Dr.h.c. Andreas Binder, M.Sc. Omar Ben Dali | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Printed Electronics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>16-17-5110 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Edgar Dörsam | | |

| | |
|---|---|
| 1 | **Content**<br>Printing technologies for functional printing (printing methods and systems); Design and materials for printed electronics (aerial, OFET, RFID); Activities for quality assurance; Examples of application (aerial, RFID, OFET, photovoltaic, batteries, lab on a chip). |
| 2 | **Learning objectives / Learning Outcomes**<br>On successful completion of this module, students should be able to:<br>• Describe the printing technologies that are applicable for "Printed Electronics".<br>• Name materials that are appropriate to printing processes and to describe the impact of the materials on the design e.g. of antennas and OFETs.<br>• Classify and rate different activites for quality assurance.<br>• Explain basic functions, configurations, materials, and specific properties of printed antennas, RFIDs, photovoltaics and batteries.<br>• Describe "Printed Electronics" as a multidisciplinary task that consists of electrical engineering, material science, and mechanical engineering. |
| 3 | **Recommended prerequisite for participation**<br>Mechanical components and Mechatronics I and II recommended |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Technical Examination, Standard Grading System)<br>Oral exam 30 min |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Technical Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>WPB Master MPE III (Wahlfächer aus Natur- und Ingenieurwissenschaft)<br>WPB Master PST III (Fächer aus Natur- und Ingenieurwissenschaft für Papiertechnik)<br>Master ETiT IMNT; Master Mechatronik |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>The current lecture notes can be downloaded from the web pages of the institute while the semester is in session. |

**Courses**

| **Course Nr.**<br>16-17-5110-vl | **Course name**<br>Printed Electronics | |
|---|---|---|
| **Instructor** | **Type**<br>Lecture | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Basic Principles of Design | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 16-17-6400 | 6 CP | 180 h | 120 h | 1 | Every 2. Sem. |
| **Language** | | | **Module owner** | | |
| German | | | Dr.-Ing. Hermann Kloberdanz | | |

| | |
|---|---|
| 1 | **Content**<br>Illustration in draft, sectional drawing, dimensioning; Functions of technical parts, screw joints, bearings, tolerances and fits; Mechanical basics of machine parts. |
| 2 | **Learning objectives / Learning Outcomes**<br>The students are able to recognise and describe position, shape and function of a mechanical component from a draft. They have the capability to prepare sketches of their own ideas applying standardised rules. Furthermore, they are able to explain the basic mechanical principles of machine components. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Technical Examination, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Technical Examination, Weighting: 100 %) |
| 6 | **Usability of this module** |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Lecture notes can be downloaded from the web pages of the institute. |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>16-17-6400-vl | **Course name**<br>Basic Principles of Design | | |
| | **Instructor** | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>16-17-6400-ue | **Course name**<br>Basic Principles of Design | | |
| | **Instructor** | | **Type**<br>Practice | **SWS**<br>2 |

| **Module name**<br>Introduction into the numerical computation of electromagnetic fields | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-sc-3010 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>75 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Sebastian Schöps | | |

| | |
|---|---|
| **1** | **Content**<br>Maxwell´s equations, basics of numerical calculation of electromagnetic fields, knowledge about different types of possible errors |
| **2** | **Learning objectives / Learning Outcomes**<br>Starting from basic electromagnetic problems in terms of electric and magnetic circuits the field aspect inherent to these models is accentuated. After attending the lecture, the student is capable of modeling given geometric structures and devices using the methods of Computational Engineering. Furthermore, the student is able to solve the related task numerically using appropriate software. The student should understand the basics of the numerical calculation of electromagnetic fields as well as become acquainted with the related procedures in practical applications. The gathered solution methods will be applied practically during the laboratory courses. Moreover basic programming skills related to specific simulation tasks as well as for the purpose of postprocessing the results of the numerical simulations are teached. |
| **3** | **Recommended prerequisite for participation**<br>Elektrotechnik und Informationstechnik I und II |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Optional, Weighting: 100 %) |
| **6** | **Usability of this module**<br>BSc CE |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References**<br>Will be handed out during the lecture and is provided at www.temf.de |

**Courses**

| | | | |
|---|---|---|---|
| **Course Nr.**<br>18-sc-3010-vl | **Course name**<br>Introduction into the numerical computation of electromagnetic fields | | |
| **Instructor**<br>Prof. Dr. rer. nat. Sebastian Schöps | | **Type**<br>Lecture | **SWS**<br>2 |
| **Course Nr.**<br>18-sc-3010-pj | **Course name**<br>Introduction into the numerical computation of electromagnetic fields | | |
| **Instructor**<br>Prof. Dr. rer. nat. Sebastian Schöps | | **Type**<br>Project Seminar | **SWS**<br>3 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Communication Networks I | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-sm-1010 | 6 CP | 180 h | 120 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| English | | | Prof. Dr.-Ing. Ralf Steinmetz | | |

**1 Content**

In this class the technologies that make today's communication networks work are introduced and discussed.

This lecture covers basic knowledge about communication networks and discusses in detail the physical layer, the data link layer, the network layer and parts of the transport layer.

The physical layer, which is responsible for an adequate transmission across a channel, is discussed briefly. Next, error control, flow control and medium access mechanisms of the data link layer are presented. Then the network layer is discussed. It comprises mainly routing and congestion control algorithms. After that basic functionalities of the transport layer are discussed. This includes UDP and TCP. The Internet is thoroughly studied throughout the class.

Detailed Topics are:

- ISO-OSI and TCP/IP layer models
- Tasks and properties of the physical layer
- Physical layer coding techniques
- Services and protocols of the data link layer
- Flow control (sliding window)
- Applications: LAN, MAN, High-Speed LAN, WAN
- Services of the network layer
- Routing algorithms
- Broadcast and Multicast routing
- Congestion Control
- Addressing
- Internet protocol (IP)
- Internetworking
- Mobile networking
- Services and protocols of the transport layer
- TCP, UDP

**2 Learning objectives / Learning Outcomes**

This lecture teaches about basic functionalities, services, protocols, algorithms and standards of network communication systems. Competencies aquired are basic knowledge about the lower four ISO-OSI layers: physical layer, datalink layer, network layer and transport layer; Furthermore, basic knowledge about communication networks is taught. Attendants will learn about the functionality of today's network technologies and the Internet.

**3 Recommended prerequisite for participation**

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 120 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

Wi-CS, Wi-ETiT, BSc CS, BSc ETiT, BSc iST

| | |
|---|---|
| 7 | **Grade bonus compliant to §25 (2)**<br>A bonus of 0.3 or 0.7 can be obtained.<br>For 0.3 bonus: 7 out of 9 exercises are to be solved to the best of your knowledge. That is, every question needs to be answered. However, not every question needs to be answered correctly. Additionally, at least one wiki article or applet concerning a topic of the lecture has to be provided (written).<br>For the 0.7 bonus: Additionally, present one exercise and write at least three wiki articles, or write at least 5 wiki articles.<br>An oral exam ("Fachgespräch") is mandatory in order to receive the bonus. The bonus can only be applied if the exam grade is 4.0 or better. |
| 8 | **References**<br>• Andrew S. Tanenbaum: Computer Networks, 5th Edition, Prentice Hall, 2010<br>• Andrew S. Tanenbaum: Computernetzwerke, 3. Auflage, Prentice Hall, 1998<br>• Larry L. Peterson, Bruce S. Davie: Computer Networks: A System Approach, 2nd Edition, Morgan Kaufmann Publishers, 1999<br>• Larry L. Peterson, Bruce S. Davie: Computernetze, Ein modernes Lehrbuch, 2. Auflage, Dpunkt Verlag, 2000<br>• James F. Kurose, Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 2nd Edition, Addison Wesley-Longman, 2002<br>• Jean Walrand: Communication Networks: A First Course, 2nd Edition, McGraw-Hill, 1998 |

**Courses**

| | | | |
|---|---|---|---|
| | **Course Nr.**<br>18-sm-1010-vl | **Course name**<br>Communication Networks I | |
| | **Instructor**<br>Prof. Dr.-Ing. Ralf Steinmetz | **Type**<br>Lecture | **SWS**<br>3 |
| | **Course Nr.**<br>18-sm-1010-ue | **Course name**<br>Communication Networks I | |
| | **Instructor**<br>Prof. Dr.-Ing. Ralf Steinmetz | **Type**<br>Practice | **SWS**<br>1 |

| Module name<br>General Computer Science II | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0290 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. rer. nat. Karsten Weihe | | |

| | |
|---|---|
| 1 | **Content**<br>In this course, students learn fundamental algorithms and data structures using advanced concepts of the programming language Java.<br>Recapitulation Basic Java:<br>* Variables, Types, Classes, Program Flow<br>* Inheritance, Abstract Classes, Interfaces<br>* Arrays and Collections<br>Advanced Programming Concepts<br>* Graphical User Interfaces<br>* Input/Output<br>* Error Handling and Exceptions<br>Algorithms and Data Structures<br>* Recursion<br>* Sorting algorithms<br>* Stacks, Lists, Queues,<br>* Search<br>* Trees and Graphs |
| 2 | **Learning objectives / Learning Outcomes**<br>After completion of this course, students are able to<br>- write larger programs in Java<br>- use fundamental algorithms and data structures of computer science<br>- estimate and compare the quality of elementary algorithms with respect to complexity and run-time |
| 3 | **Recommended prerequisite for participation**<br>General Computer Science I or<br>- elementary programming skills in Java<br>- basic knowledge in computer science<br>- working with computers |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0290-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module** |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

Java lernen mit BlueJ: Eine Einführung in die objektorientierte Programmierung David J. Barnes, Michael Kölling Pearson Studium 4., aktualisierte Auflage, 2009
ISBN-13: 978-3-8689-4001-5
Algorithmen in Java
Robert Sedgewick
Pearson Studium
3. überarbeitete Auflage, 2003
ISBN-13: 978-3-8273-7072-3
Einführung in die Programmierung mit Java Robert Sedgewick, Kevin Wayne Pearson Studium 1. Auflage, 2011
ISBN-13: 978-3-8689-4076-3

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 20-00-0290-iv | General Computer Science II | | |
| **Instructor** | | **Type** Integrated Course | **SWS** 4 |

| Module name<br>Lighting Technology I | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kh-2010 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Khanh Quoc Tran | | |

| | |
|---|---|
| 1 | **Content**<br>Structure and functionality of the human eye, terms and unit in lighting technology, photometry, radiometric and photometric properties of materials, filters, physiology of vision, colour theory, lighting, light sources.<br>Measurement of luminous flux, luminous intensity, illuminance, luminance, determination of the spectral responsivity function of the human eye, colorimetry colour rendering, colour as traffic signals, measuring of optical material characteristics, LED properties |
| 2 | **Learning objectives / Learning Outcomes**<br>To list and connect terms, units and radiometric and photometric properties of materials in lighting technology, to describe and understand structure and functionality of the human eye and the physiology of vision, to illustrate basics of lighting, measuring methods and application.<br>Being able to measure base items in lighting technology, applying knowlegde of lighting and enhance them with experiments. Developing a better understanding for light and color. |
| 3 | **Recommended prerequisite for participation**<br>MSc ETiT, MSc Wi-ETiT, MSc MEC |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Oral Examination, Duration: 30 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Technical Examination, Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>MSc ETiT, MSc Wi-ETiT, MSc MEC |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Script for lecture: Lighting Technology I<br>Excersisebook: laboratory: lighting technology I |

**Courses**

| | | | | |
|---|---|---|---|---|
| | **Course Nr.**<br>18-kh-2010-vl | **Course name**<br>Lighting Technology I | | |
| | **Instructor**<br>Prof. Dr.-Ing. Khanh Quoc Tran | | **Type**<br>Lecture | **SWS**<br>2 |
| | **Course Nr.**<br>18-kh-2010-pr | **Course name**<br>Lighting Technology I | | |
| | **Instructor**<br>Prof. Dr.-Ing. Khanh Quoc Tran | | **Type**<br>Internship | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| System Dynamics and Automatic Control Systems II | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ad-1010 | 7 CP | 210 h | 135 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Jürgen Adamy | | |

**1 Content**

Main topics covered are:

- Root locus method (construction and application),
- State space representation of linear systems (representation, time solution, controllability, observability, observer- based controller design)

**2 Learning objectives / Learning Outcomes**

After attending the lecture, a student is capable of:

- constructing and evaluating the root locus of given systems
- describing the concept and importance of the state space for linear systems
- defining controllability and observability for linear systems and being able to test given systems with respect to these properties
- stating controller design methods using the state space, and applying them to given systems
- applying the method of linearization to non-linear systems with respect to a given operating point

**3 Recommended prerequisite for participation**

System Dynamics and Control Systems I

**4 Form of examination**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Duration: 180 min, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Technical Examination, Written Examination, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, MSc MEC, MSc iST, MSc WI-ETiT, MSc iCE, MSc EPE, MSc CE, MSc Informatik

**7 Grade bonus compliant to §25 (2)**

**8 References**

Adamy: Systemdynamik und Regelungstechnik II, Shaker Verlag (available for purchase at the FG office)

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-ad-1010-vl | System Dynamics and Automatic Control Systems II | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Jürgen Adamy | | Lecture | 3 |
| **Course Nr.** | **Course name** | | |
| 18-ad-1010-ue | System Dynamics and Automatic Control Systems II | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr.-Ing. Jürgen Adamy | | Practice | 2 |

| **Module name**<br>Computational Engineering and Robotics | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0011 | **Credit Points**<br>5 CP | **Workload**<br>150 h | **Self study**<br>105 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. phil. nat. Marc Fischlin | | |

| | |
|---|---|
| 1 | **Content**<br>- Foundations of modelling and simulation<br>- Problem specification and system description for computational engineering<br>- Model generation for the example of mechanical systems<br>- Model analysis for the example of mechanical systems<br>- Implementations of simulations for the example of robots and other systems<br>- Interpretation and validation using measurement data<br>- Applications in simulation and control of robots as well as in physically based animation and computer games |
| 2 | **Learning objectives / Learning Outcomes**<br>Upon successful completion of this class, students will be able to develop first models and simulations and can perform first simulation studies within robotics. They know the necessary key steps needed to construct simulations (problem specification, model generation, model analysis, implementation, and validation) and can use them to construct first simulations to meet the specification requirements. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0011-iv] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0011-iv] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>B.Sc. Informatik<br>B.Sc. Wirtschaftsinformatik<br>B.Sc. Computational Engineering<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>B.Sc. Informationssystemtechnik<br>May be used in other degree programs. |
| 7 | **Grade bonus compliant to §25 (2)**<br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| 8 | **References**<br>F. Föllinger: Einführung in die Zustandsbeschreibung dynamischer Systeme (Oldenbourg, 1982)<br>P. Corke: Robotics, Vision & Control, Springer, 2011<br>F.L. Severance: System Modeling and Simulation: An Introduction, J. Wiley & Sons, 2001 |
| **Courses** | |

| | Course Nr. | Course name | | |
|---|---|---|---|---|
| | 20-00-0011-iv | Computational Engineering and Robotics | | |
| | **Instructor** | | **Type** Integrated Course | **SWS** 3 |

| Module name<br>Robot Learning | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>20-00-0629 | **Credit Points**<br>6 CP | **Workload**<br>180 h | **Self study**<br>120 h | **Duration**<br>1 | **Cycle offered**<br>Every 2. Sem. |
| **Language**<br>English | | | **Module owner** | | |

| | |
|---|---|
| 1 | **Content**<br>- Foundations from robotics and machine learning for robot learning<br>- Learning of forward models<br>- Representation of a policy, hierarchical abstraction wiith movement primitives<br>- Imitation learning<br>- Optimal control with learned forward models<br>- Reinforcement learning and policy search<br>- Inverse reinforcement learning |
| 2 | **Learning objectives / Learning Outcomes**<br>Upon successful completion of this course, students are able to understand the relevant foundations of machine learning and robotics. They will be able to use machine learning approaches to empower robots to learn new tasks. They will understand the foundations of optimal decision making and reinforcement learning and can apply reinforcement learning algorithms to let a robot learn from interaction with its environment. Students will understand the difference between Imitation Learning, Reinforcement Learning, Policy Search and Inverse Reinforcement Learning and can apply each of this approaches in the appropriate scenario. |
| 3 | **Recommended prerequisite for participation**<br>Good programming in Matlab<br>Lecture Machine Learning 1 - Statistical Approaches is helpful but not mandatory. |
| 4 | **Form of examination**<br>Module Eccompanying Examination:<br>• [20-00-0629-vl] (Technical Examination, Written/Oral Examination, Standard BWS) |
| 5 | **Grading**<br>Module Eccompanying Examination:<br>• [20-00-0629-vl] (Technical Examination, Written/Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>B.Sc. Informatik<br>M.Sc. Informatik<br>B.Sc. Computational Engineering<br>M.Sc. Computational Engineering<br>M.Sc. Wirtschaftsinformatik<br>B.Sc. Psychologie in IT<br>Joint B.A. Informatik<br>B.Sc. Sportwissenschaft und Informatik<br>M.Sc. Sportwissenschaft und Informatik<br>Can be used in other degree programs. |
| 7 | **Grade bonus compliant to §25 (2)**<br>In dieser Vorlesung findet eine Anrechnung von vorlesungsbegleitenden Leistungen statt, die lt. §25 (2) der 5. Novelle der APB und den vom FB 20 am 30.3.2017 beschlossenen Anrechnungsregeln zu einer Notenverbesserung um bis zu 1.0 führen kann. |
| 8 | **References** |

Deisenroth, M. P.; Neumann, G.; Peters, J. (2013). A Survey on Policy Search for Robotics, Foundations and Trends in Robotics
Kober, J; Bagnell, D.; Peters, J. (2013). Reinforcement Learning in Robotics: A Survey, International Journal of Robotics Research
C.M. Bishop, Pattern Recognition and Machine Learning (2006),
R. Sutton, A. Barto. Reinforcement Learning - an Introduction
Nguyen-Tuong, D.; Peters, J. (2011). Model Learning in Robotics: a Survey

**Courses**

| **Course Nr.** | **Course name** | | |
|---|---|---|---|
| 20-00-0629-vl | Robot Learning | | |
| **Instructor** | | **Type** | **SWS** |
| | | Lecture | 4 |

| **Module name**<br>Seminar Terahertz Components & Applications | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-pr-1010 | **Credit Points**<br>4 CP | **Workload**<br>120 h | **Self study**<br>90 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr. rer. nat. Sascha Preu | | |

**1 Content**

Investigating and solving specific problems concerning the development of Terahertz devices as well as of applications of THz technology. The specific task will be defined based on current research topics. The project seminar includes working on a given task by one's own, organizing and structuring of a seminar task, searching and analyzing of scientific reference publications, summarizing achieved results and conclusions by means of a written report, presenting achieved results and conclusions and defending them in an oral discussion including audience. Topics include, e.g.:

- Optics on chip
- Semiconductor devicesLight-matter interaction

**2 Learning objectives / Learning Outcomes**

After completion of the course, students possess:

- the ability to apply theoretical models to practical problems
- deep and special knowledge in a particular field related to THz science, optics or semiconductor physics
- the skills to find, analyze and evaluate scientific reference papers for a particular topic
- the capability to summarize the achieved scientific findings in the form of a concise reportthe ability to present and discuss achieved results in the form of a presentation in front of an audience

**3 Recommended prerequisite for participation**

Previous knowledge one of the following disciplines: Optics, semiconductor physics, or THz technology

**4 Form of examination**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Standard Grading System)

**5 Grading**

Module Final Examination:

- Module Examination (Study Achievement, Optional, Weighting: 100 %)

**6 Usability of this module**

BSc ETiT, BSc Wi-ETiT, BSc/MSc iST

**7 Grade bonus compliant to §25 (2)**

**8 References**

Will be announced once the topic is defined.

**Courses**

| **Course Nr.**<br>18-pr-1010-se | **Course name**<br>Seminar Terahertz Components & Applications | |
|---|---|---|
| **Instructor**<br>Prof. Dr. rer. nat. Sascha Preu | **Type**<br>Seminar | **SWS**<br>2 |

| Module name | | | | | |
|---|---|---|---|---|---|
| C/C++ Programming Lab | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-su-1030 | 3 CP | 90 h | 45 h | 1 | SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr. rer. nat. Andreas Schürr | | |

| | |
|---|---|
| 1 | **Content**<br>The six-day programming lab is divided into two sections.<br>In the first four days, the programming languages C and C++ are taught with practical tasks and lectures. All covered aspects are extensively practiced under supervision. Based on the fundamental basics of C++, manual memory management and dynamic data structures are handled from a procedural as well as from an object-oriented perspective. Object orientation with C++ is extensively addressed by treating multiple inheritance, polymorphism and parametric polymorphism.<br>The last two days are dedicated to microcontroller programming in C including the opportunity of programming of a distributed application (via a CAN-bus). |
| 2 | **Learning objectives / Learning Outcomes**<br>During the lab, the students acquire a fundamental understanding of the programming languages C and C++ with emphasis not only on procedural but also on object-oriented characteristics. The students gain hands-on experience with applying C++ and discover the challenges of using C++ safely and properly especially in the context of embedded system software development. |
| 3 | **Recommended prerequisite for participation**<br>Java skills |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST, BSc Wi-ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>http://www.es.tu-darmstadt.de/lehre/aktuelle-veranstaltungen/c-und-c-p |

**Courses**

| Course Nr. | Course name | | |
|---|---|---|---|
| 18-su-1030-pr | C/C++ Programming Lab | | |
| **Instructor** | | **Type** | **SWS** |
| Prof. Dr. rer. nat. Andreas Schürr | | Internship | 3 |

| Module name | | | | | |
|---|---|---|---|---|---|
| Seminar Electronic Circuits | | | | | |
| **Module Nr.** | **Credit Points** | **Workload** | **Self study** | **Duration** | **Cycle offered** |
| 18-ho-1070 | 4 CP | 120 h | 90 h | 1 | WiSe/SoSe |
| **Language** | | | **Module owner** | | |
| German | | | Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Analysis of state-of-the-art circuit concepts and presentation of selected examples |
| 2 | **Learning objectives / Learning Outcomes**<br>After attending the seminar, a student is capable of analysing of state-of-the-art circuit concepts and preparing didactical materials and presentations, based on the know-how gained in the lectures “Electronics” and “Analog Integrated Circuit Design” |
| 3 | **Recommended prerequisite for participation**<br>Electronics, Analog Integrated Circuit Design |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Oral Examination, Duration: 30 min, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Oral Examination, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Will be provided at the begin of the seminar |

**Courses**

| | **Course Nr.** | **Course name** | | |
|---|---|---|---|---|
| | 18-ho-1070-se | Seminar Electronic Circuits | | |
| | **Instructor** | | **Type** | **SWS** |
| | Prof. Dr.-Ing. Klaus Hofmann | | Seminar | 2 |

### 3.5.3.2 SAE - Proseminar (open catalogue)

| | | | | | |
|---|---|---|---|---|---|
| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
| **Module Nr.**<br>18-bu-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>60 h | **Duration**<br>1 | **Cycle offered**<br>WiSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Ph.D. Thomas Peter Burg | | |
| **1** | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. | | | | |
| **2** | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. | | | | |
| **3** | **Recommended prerequisite for participation** | | | | |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) | | | | |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) | | | | |
| **6** | **Usability of this module**<br>BSc ETiT, BSc MEC, BSc iST | | | | |
| **7** | **Grade bonus compliant to §25 (2)** | | | | |
| **8** | **References** | | | | |
| **Courses** | | | | | |

| Module name<br>Proseminar ETiT | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kn-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr. Mario Kupnik | | |

| | |
|---|---|
| **1** | **Content** |
| **2** | **Learning objectives / Learning Outcomes** |
| **3** | **Recommended prerequisite for participation** |
| **4** | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| **5** | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| **6** | **Usability of this module** |
| **7** | **Grade bonus compliant to §25 (2)** |
| **8** | **References** |

**Courses**

| **Course Nr.**<br>18-kn-1000-ps | **Course name**<br>Proseminar ETiT | | |
|---|---|---|---|
| **Instructor**<br>Prof. Dr. Mario Kupnik | | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-ho-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German and English | | | **Module owner**<br>Prof. Dr.-Ing. Klaus Hofmann | | |

| | |
|---|---|
| 1 | **Content**<br>Analysis of basic electronic circuits and presentation of selected examples |
| 2 | **Learning objectives / Learning Outcomes**<br>After attending the seminar, a student is capable of analysing basic electronic circuits and preparing didactical materials and presentations |
| 3 | **Recommended prerequisite for participation**<br>Electronics |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References**<br>Will be provided at the begin of the seminar |

**Courses**

| **Course Nr.**<br>18-ho-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | |
|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Klaus Hofmann | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |

| **Module name**<br>Proseminar Electrical Engineering and Information Technology | | | | | |
|---|---|---|---|---|---|
| **Module Nr.**<br>18-kh-1000 | **Credit Points**<br>2 CP | **Workload**<br>60 h | **Self study**<br>30 h | **Duration**<br>1 | **Cycle offered**<br>WiSe/SoSe |
| **Language**<br>German | | | **Module owner**<br>Prof. Dr.-Ing. Khanh Quoc Tran | | |

| | |
|---|---|
| 1 | **Content**<br>Read published books or papers on a given subject in Electrical Engineering and Information Technology. Write a summary and present it using multi media technology. Additional information can be found here. |
| 2 | **Learning objectives / Learning Outcomes**<br>The student will be able to understand and analyse scientific papers, to present technical facts properly and well structured. He knows how to summarize and present the given topic. |
| 3 | **Recommended prerequisite for participation** |
| 4 | **Form of examination**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Standard Grading System) |
| 5 | **Grading**<br>Module Final Examination:<br>• Module Examination (Study Achievement, Optional, Weighting: 100 %) |
| 6 | **Usability of this module**<br>BSc ETiT |
| 7 | **Grade bonus compliant to §25 (2)** |
| 8 | **References** |

**Courses**

| **Course Nr.**<br>18-kh-1000-ps | **Course name**<br>Proseminar Electrical Engineering and Information Technology | |
|---|---|---|
| **Instructor**<br>Prof. Dr.-Ing. Khanh Quoc Tran | **Type**<br>Introductory Seminar Course | **SWS**<br>2 |