Module Handbook

Bachelor’s Program:

Kommunikations- und Informationstechnik
(Communications Engineering and Information Technology)

Bachelor of Engineering

As of: October 30th, 2008
1. Module

1.1 First Semester

1.1.1 Mathematics I

Course title: Mathematics I
Course code: KI1B110
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 6
Semester: 1st semester
Name of the lecturer: Prof. Dr. rer. nat. Reiner Dussel

Course contents:
- Analytic geometry in the space
- Linear algebra
- Basic concepts of mathematics (sets, logics, statements, proof rules)
- Numbers (real, complex)
- Simple equations and inequations
- Sequences and convergence
- Limits of sequences
- Mapping and functions with one variable only
- Introduction of the most common functions
- Limit and continuity of real valued functions
- Derivatives
- Applications of derivatives (extreme values, approximations)

Prerequisites: -

Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:
- be able to correctly handle basic mathematical concepts,
- be able to solve basic problems in the fields mentioned above,
- be able to transfer the theoretical concepts to engineering problems.

Language of instruction: German
Teaching methods: Lecture supported by blackboard notes
Assessment methods:
- [x] Written exam
- [ ] Presentation
- [ ] Written assignment
- [ ] Project work
- [ ] Oral exam
- [ ] Practical exercises

Recommended reading:
- Westermann, Mathematik für Ingenieure
- Papula, Mathematik für Ingenieure und Naturwissenschaftler Band 1
- Meyberg, Vachenauer: Höhere Mathematik 1, Springer Verlag

1.1.2 Electrical Engineering I

Course title: Electrical Engineering I
Module

Course code: KI 1B120
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 3
Semester: 1st semester
Name of the lecturer: Prof. Dr. Manfred Strohmann, Prof. Dr. Manfred Litzenburger
Course contents:
• Fundamentals: Electrical charge, current, voltage, power, energy
• Passive and active two-poles, ideal and real sources, superposition
• Analysis of DC networks, Kirchhoff’s laws
• Impedance matching
• Node voltage analysis
• Introduction to operational amplifiers
Prerequisites: Basic knowledge in Mathematics and Physics
Course objectives expressed in learning outcomes and competences:
• be able to handle physical equations with units of measurements,
• know the basic principles of electricity,
• understand the fundamental interrelations between electrical quantities,
• be able to analyse linear DC circuits,
• know the applications of operational amplifiers and be able to analyse circuits with operational amplifiers.
Language of instruction: German
Teaching methods: Lecture supported by transparencies and lecture notes
Assessment methods:
☑ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐
Recommended reading:

1.1.3 Fields

Course title: Fields
Course code: KI1B121
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 3
Semester: 1st semester
Name of the lecturer: Prof. Dr. Hans A. Sapota
Course contents:

- Basics, electrical charge, voltage, electrical field strength
- Calculation of electrical fields
- Capacity
- Forces in electrical fields
- Magnetic fields
- Calculation of magnetic fields
- Induction
- Inductance
- Forces in magnetic fields
- Maxwell's equations

Prerequisites: -

Course objectives expressed in learning outcomes and competences:

After having successfully completed the course, the students should:

- have detailed knowledge of electrical and magnetic fields,
- be able to apply Maxwell's equation.

Language of instruction: German

Teaching methods: Lecture supported by blackboard notes, Power Point slides and transparencies

Assessment methods:

- Written exam
- Presentation
- Written assignment
- Project work
- Oral exam
- Practical exercises

Recommended reading:

Büttner, W.-E.: Grundlagen der Elektrotechnik 1, Oldenburg, München, 1. Aufl. 2004

1.1.4 Digital Circuit Design

Course title: Digital Circuit Design
Course code: KI1B130
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 4
Semester: 1st semester
Name of the lecturer: Prof. Dr. J. Stöckle

Course contents:

Within the past two decades, digital electronics have widely replaced analog circuitry. Our technical environment is preferably digital, totally in contrast to nature, which is based on analog methods. Examples are the quartz watch, digital communication (ISDN), computer, gameboy, mobile phone, CD player or every day's traffic lights. Beginning with the smallest information unit of 1 bit, this lecture deals with methods for developing and realising digital applications. Some key words are: codes and coding, error correction, Hamming coding, Boolean algebra, truth table, Karnaugh Veitch diagram, combinational logics, flip flops, finite state machines, counters, multiplexers, programmable logic devices (PLD).

Prerequisites: -

Course objectives expressed in learning

After having successfully completed the course, the students should:
outcomes and competences:

- be able to design digital electronics with discrete parts,
- be able to design digital circuits on the basis of programmable logic devices.

Language of instruction: German

Teaching methods: Lecture supported by lecture notes, transparencies, practical exercises, industrial films and design software

Assessment methods:
- Written exam
- Written assignment
- Oral exam
- Practical exercises

Recommended reading:
Pernards, Peter: Digitaltechnik. Hüthig, Heidelberg

1.1.5 Digital Design Lab

Course title: Digital Design Lab
Course code: KI1B131
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 4
Semester: 1st semester
Name of the lecturer: Prof. Dr. J. Stöckle

Course contents: Today, digital circuitry is only rarely realised with a lot of discrete parts like transistors or integrated circuits with small functionality. The intensive use of programmable logic devices (PLD) is state of the art. The digital circuitry is designed via software and loaded into the PLD. This method is presented in the lab with the help of 6 experiments. The digital circuit is designed with the software "ispLever", produced by Lattice. Every student gets an unlimited version of this software in order to be able to perform exercises at home. Circuits are defined by a program using the language ABEL or by a schematics entry. Each design is verified with a board consisting of a PLD of the type MACH M4-64/32 and a lot of switches, LEDs and displays. Exemplary experiments deal with the following topics: comparator for two numbers, parity generator, walking light, 4 bit counter, decade counter, stop watch, measuring the velocity of model cars.

Prerequisites: Basic knowledge in Digital Circuit Design.

Course objectives expressed in learning outcomes and competences:

- be able to design digital systems using programmable logic devices (PLD),
- be able to manage the whole design process for programmable logic devices (PLD).

Language of instruction: German

Teaching methods: Laboratory course supported by the software ispLever and the MACH demo board

Assessment methods:
- Written exam
- Written assignment
- Oral exam
- Practical exercises

Recommended
Module

1.1.6 Information Technology 1

Course title: Information Technology 1
Course code: N1B140
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 6
Semester: 1st semester
Name of the lecturer: Prof. Dr. M. Katz, Prof. Dr. K. Wolfrum

Course contents:
- Architecture of a programming language, lexical and syntactic structure
- Conception of algorithms, introductory examples in C
- The program development process: editor, compiler, linker
- Structograms and documentation, program flow charts, Nassi Shneiderman structograms
- Data types, variables, constants
- Operators, arithmetic expressions, assignments
- Control instructions (while, for, do-while)
- Functions and formal parameters
- Pointers, indexing of pointers using address arithmetics

Programming Exercises
- Integrated development environment IDE,
- Editor, compiler, linker, debugger
- Structure and run-time behavior of control instructions
- Range of elementary data types, overflow conditions
- Execution order of operators
- Structure of main memories, stacks and heaps
- Indexing and addressing

Prerequisites: Basic technical computer skills

Course objectives expressed in learning outcomes and competences:
- know the fundamental steps of software development with an IDE,
- be aware of the limited range and accuracy of digitally represented numbers,
- be able to implement algorithms to safely running programs.

Language of instruction: German

Teaching methods: Lecture supported by blackboard notes, transparencies, the presentation of examples by means of a beamer, and practical programming exercises

Assessment methods: ☑ Written exam ☐ Presentation
☐ Written assignment ☐ Project work
☐ Oral exam ☑ Practical exercises

Recommended reading:
RRZN (Regionales Rechenzentrum für Niedersachsen), Die
1.1.7 Physics

Course title: Physics
Course code: KI1B150
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 4
Semester: 1st semester
Name of the lecturer: Prof. Dr. Hubert Schwab

Course contents:

- Lecture:
  - Basic concepts of mechanics: force, energy, conservative laws
  - Oscillations, waves and their properties
  - Light as an electro-magnetic wave
  - Geometrical and wave optics

- Laboratory with experiments in:
  - Viscosity
  - Oscillations
  - Lenses and lens systems

Prerequisites: Basic knowledge in Mathematics and Physics

Course objectives expressed in learning outcomes and competences:

- know basic concepts in mechanics and optics,
- know the principles of mechanic oscillations and waves and know how these principles are confered to light as electro-magnetic waves,
- be able to describe the propagation of light in geometrical optics (p.e. reflection, refraction) and wave optics (p.e. diffraction),
- be able to design the image of an object in optical systems (p.e. plane, concave and convex mirrors, lenses and lens systems) and know the functional principles of optical systems.

Language of instruction: German

Teaching methods: Lecture supported by lecture notes, blackboard notes, transparencies and practical exercises

Assessment methods: ☒ Written exam ☐ Presentation ☐
☒ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐

Recommended reading:
P. Dobrinski, Physik für Ingenieure, Teubner Verlag Wiesbaden, 2003
U. Harten, Physik, Springer Verlag, Heidelberg 2004
Tipler, Mosca, Physik, Spektrum Akademischer Verlag, München, 2004
F. Kuypers, Band 1: Mechanik und Thermodynamik und Band 2: Elektrizität, Magnetismus, Wellen, Atom- und Kernphysik, VCH-Verlag
1.2 Second Semester

1.2.1 Mathematics 2

Course title: Mathematics 2
Course code: KI2B210
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 6
Semester: 2nd semester
Name of the lecturer: Prof. Dr. rer. nat. Reiner Dussel

Course contents:
- Linear algebra
- Definite integrals and Riemann sum
- Indefinite integrals
- Fundamental theorem
- Integration rules (substitution, integration by parts)
- Applications of integral calculus (centre of gravity, rotational objects)
- Improper integrals
- Infinite series and power series
- Expansions (Fourier series, Taylor series)
- Ordinary differential equations

Prerequisites: Mathematics 1

Course objectives expressed in learning outcomes and competences:
- be able to correctly handle basic mathematical concepts,
- be able to solve basic problems in the fields mentioned above,
- be able to transfer the theoretical concepts to engineering problems.

Language of instruction: German

Teaching methods: Lecture supported by blackboard notes

Assessment methods:
- Written exam
- Written assignment
- Oral exam

Recommended reading:
- Westermann, Mathematik für Ingenieure
- Papula, Mathematik für Ingenieure und Naturwissenschaftler Band 1+2
- Meyberg, Vachenauer: Höhere Mathematik 1+2, Springer Verlag
- Merziger, Wirth, Repetitorium der höheren Mathematik

1.2.2 Basic Electrical Engineering 2

Course title: Basic Electrical Engineering 2
Course code: KL2B220
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Module

1.2.3 Basics Electrical Engineering Laboratory

Course title: Basics Electrical Engineering Laboratory
Course code: KL2B221
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 2
Semester: 2nd semester
Name of the lecturer: Prof. Dr. Manfred Strohmann
Course contents:
- Voltage and current sources, measuring with multi-meters
- Stabilisation of voltages
- Basic circuits with operational amplifiers
- RC filter applications
- Resonance interpretation in RLC networks
Prerequisites: Successful test in DC circuits
Course objectives After having successfully completed the course, the students should:
expressed in learning outcomes and competences:

- be able to work with multi-meters and oscilloscopes,
- have improved their knowledge of electric circuits,
- be able to install electrical circuits,
- be able to interpret test results.

Language of instruction: German
Teaching methods: Laboratory course with practical experiments
Assessment methods:
- Written exam
- Presentation
- Written assignment
- Project work
- Oral exam
- Practical exercises

Recommended reading: Moeller, Grundlagen der Elektrotechnik, Teubner, Wiesbaden, 2002

1.2.4 Microcontroller Systems

Course title: Microcontroller Systems
Course code: KI 2B230
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 4
Semester: 2nd semester
Name of the lecturer: Prof. Dr.-Ing. Gerhard Schäfer

Course contents: Microcontroller systems are presented as a fast and general problem solution platform. The basic concept of a standard hardware which is customised by software will be introduced with special regard to the solution of time-controlled and event-controlled processes. The building blocks of a microcontroller are discussed with regard to their typical application. In addition, the lecture deals with I/O processing and interrupt handling. The programming solutions will be found both in Assembler and C.

Prerequisites: C-programming, digital circuits

Course objectives expressed in learning outcomes and competences:

After having successfully completed the course, the students should:

- be able to solve an application problem by means of a microcontroller,
- know the structure and functionality of a microcontroller system,
- be able to write assembler programs,
- be able to program a microcontroller in C,
- be able to handle external I/O signals and interrupts.

Language of instruction: German
Teaching methods: Lecture supported by transparencies, Power Point slides and program demonstrations
Assessment methods:
- Written exam
- Presentation
- Written assignment
- Project work
- Oral exam
- Practical exercises

Recommended reading: Jürgen Maier-Wolf, 8051 Mikrocontroller erfolgreich anwenden, Franzis, 1996
1.2.5 Microcontroller Laboratory

Course title: Microcontroller Laboratory
Course code: KI 2B231
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 4
Semester: 2nd semester
Name of the lecturer: Prof. Dr.-Ing. Gerhard Schäfer

Course contents: The following practical exercises related to the lecture of Microcontroller Systems are performed:
- Port Input/Outputs
- Time-dependent control of peripheral devices
- Debouncing of buttons and interrupt handling
- A/D conversion
- Serial data transmission

Prerequisites: C-Programming, Digital Circuits

Course objectives expressed in learning outcomes and competences:
- be able to use a microcontroller development system,
- be able to handle external data in a microcontroller,
- know the structure and functionality of an interrupt system,
- be able to write and debug assembler programs,
- be able to program and debug a microcontroller in C.

Language of instruction: German

Teaching methods: Practical exercises with the help of an evaluation board and a microcontroller design system

Assessment methods: [ ] Written exam [ ] Presentation [ ]
[ ] Written assignment [ ] Project work
[ ] Oral exam [ ] Practical exercises [ ]

Recommended reading:
Jürgen Maier-Wolf, 8051 Mikrocontroller erfolgreich anwenden, Franzis, 1996
Burkhard Mann, C für Mikrocontroller, Franzis, 2000
1.2.6 Signal And Systems

Course title: Signals And Systems
Course code: KL2B250
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 4
Semester: 2nd semester
Name of the lecturer: Prof. Dr. Manfred Strohrmann

Course contents:
- Modelling of linear time-invariant systems
- Characterisation of and calculation with signals
- Solving of linear differential equations
- Laplace Transform
- Laplace transfer function
- Fourier Transform
- Application for linear systems

Prerequisites: -

Course objectives expressed in learning outcomes and competences:
- be able to describe systems with differential equations
- have improve the knowledge about functions and signals
- be able to solve linear differential equations
- be able to apply Laplace Transform
- have learned to describe system with transfer functions
- be able to apply Fourier-Transform
- have learned to use Fourier Transform for analysis and synthesis of systems

Language of instruction: German

Teaching methods: Lectures and exercises, experiments for illustration

Assessment methods: ✗ Written exam  ☐ Presentation  ☐
☐ Written assignment  ☐ Project work  ☐
☐ Oral exam  ☐ Practical exercises  ☐

Recommended reading:
Scheidthauer R. Signals und Systeme, Teubner Verlag, Wiesbaden, 2005
Girod, B., Einführung in die Systemtheorie, Teubner Verlag, Wiesbaden, 2005

1.2.7 Information Technology 2

Course title: Information Technology 2
Course code: N2B240
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: First year
ECTS Credits: 6
Semester: 2nd semester
Name of the lecturer: Prof. Dr. M. Katz, Prof. Dr. K. Wolfrum
Course contents: Lecture
• Short review of elementary fundamentals
• Functions, call by reference, scope of variables
• Modular programming of complex algorithms
• Arrays, vectors, matrices, strings
• Structures, recursive structures
• Recursive algorithms
• Concatenated data sets
• Object-oriented programming paradigms, introduction to C++
• Classes, methods, inheritance, overloading operators

Programming Exercises
• Creating, debugging and running more complex C and C++ programs
• Using data structures and data manipulation algorithms
• Parsing of strings
• Reading from and writing to external media

Prerequisites: Information Technology 1
Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:
• know elaborate program development methods,
• be able to work on a given task to a well-structured algorithm while avoiding side effects,
• be familiar with object-oriented programming techniques such as inheritance, overloading and the programming language C++.

Language of instruction: German
Teaching methods: Lecture supported by blackboard notes, transparencies, the presentation of examples by means of a beamer, and practical programming exercises
Assessment methods: ☒ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work ☐ Oral exam ☒ Practical exercises

Recommended reading:
RRZN (Regionales Rechenzentrum für Niedersachsen), C++ für C-Programmierer, Begleitmaterial zu Vorlesungen/Kursen
D. Louis, C/C++ Kompendium, Markt und Technik Verlag, München
D. Louis, C/C++ Referenz, Markt und Technik Verlag, München
1.3 Third Semester

1.3.1 Mathematics 3

Course title: Mathematics 3  
Course code: KI3B310, KI3B311  
Type of course: Lecture  
Level of course: Bachelor  
Degree Program: Communications Engineering and Information Technology  
Year of study: Second year  
ECTS Credits: 6  
Semester: 3rd semester  
Name of the lecturer: Prof. Dr. rer. nat. Reiner Dussel

Course contents:
- Multivariable and vector valued functions
- Limits and continuity for multivariable and vector valued functions
- Derivative (total derivative, partial derivative, chain rule)
- Taylor expansion for multivariable functions
- Applications (extreme values with/without constraints, implicit functions)
- Differential operators (gradient, divergence, curl)
- Multiple integrals
- Integration over vector valued function
- Applications (Maxwell equations)
- Fourier and Laplace transformation
- Introduction to MATLAB
- Basic concepts of numerical mathematics
- Applications to different areas (Integration, linear algebra, ordinary differential equations, approximation of functions, optimization, roots)

Prerequisites: Mathematics 2

Course objectives expressed in learning outcomes and competences:
- be able to correctly handle basic mathematical concepts,
- be able to solve basic problems in the fields mentioned above,
- be able to transfer the theoretical concepts to engineering problems,
- be able to make use of the software package MATLAB,
- be able to handle numerical problems.

Language of instruction: German

Teaching methods: Lecture supported by blackboard notes and beamer presentations

Assessment methods: [ ] Written exam  [ ] Presentation  
[ ] Written assignment  [ ] Project work  
[ ] Oral exam  [ ] Practical exercises

Recommended reading: Westermann, Mathematik für Ingenieure  
Papula, Mathematik für Ingenieure und Naturwissenschaftler Band 1+2+3  
Meyberg, Vachenauer: Höhere Mathematik 1+2, Springer Verlag  
Merziger, Wirth, Repetitorium der höheren Mathematik
1.3.2 Measurement Technology

Course title: Measurement Technology  
Course code: KI3B320  
Type of course: Lecture  
Level of course: Bachelor  
Degree Program: Communications Engineering and Information Technology  
Year of study: Second year  
ECTS Credits: 4  
Semester: 3rd semester  
Name of the lecturer: Prof. Dr. K. Wolfrum  
Course contents:  
• Units and dimensions  
• Systematical and statistical errors and error propagation, effect of noise  
• Electromechanical instruments  
• Measurement of current and voltage by means of transducers and transformers  
• Signal conditioning with operational amplifiers  
• Digital data acquisition, digital-analog and analog-digital converters  
• Analog and digital storage oscilloscopes  
• Examples of measuring technologies for non-electric quantities, e.g. temperature  
Prerequisites: Fundamental knowledge in Electrical Engineering (direct current, alternating current, electric and magnetic fields), Mathematics 1 and Mathematics 2  
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:  
• know basic and elaborate methods for measuring electric and non-electric quantities,  
• be familiar with basic electronic circuits for signal conditioning,  
• be able to estimate the confidence range of measurements by using statistical methods of error propagation,  
• be aware of the prerequisites and limitations of digital signal acquisition, i.e. aliasing, quantisation errors etc.  
Language of instruction: German  
Teaching methods: Lecture supported by blackboard notes, transparencies, beamer presentations, and practical programming exercises  
Assessment methods:  
☐ Written exam  
☐ Presentation  
☐ Written assignment  
☐ Project work  
☐ Oral exam  
☐ Practical exercises  
Recommended reading:  
R. Lerch, Elektrische Messtechnik, Springer Verlag, Berlin  
E. Schröfer, Elektrische Messtechnik, Springer Verlag, Berlin  
T. Mühl, Einführung in die elektrische Messtechnik, Teubner Verlag, Stuttgart  
K. Bergmann, Messtechnik, Teubner Verlag, Stuttgart  

1.3.3 Measurement Technique Laboratory

Course title: Measurement Technology Laboratory  
Course code: KI3B321  
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 2
Semester: 3rd semester
Name of the lecturer: Prof. Dr. K. Wolfrum
Course contents: Laboratory work accompanying the lecture of Measurement Technology
  - Analog oscilloscope applications:
    Consideration and characterisation of elementary signals, trigger modes, y-t and x-y operational modes
  - Digital storage oscilloscope:
    Consideration and characterisation of elementary signals by means of implemented mathematical functions, characterization of harmonics by means of FFT
  - Computer-aided temperature measurement on a heat sink mounted power transistor, characterisation of thermal resistance etc.
  - Basic properties of operational amplifiers
  - Amplifier circuits for signal conditioning
  - Simulation of digital-analog and analog-digital converters by means of PSPICE
Prerequisites: Accompanying lecture Measurement Technology and prerequisites mentioned there
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:
  - be familiar with electrical measurement equipment, especially with the set-up of analog and digital oscilloscopes,
  - be able to set up and use measurement systems,
  - have experience in estimating possible error sources,
  - have experience in writing concise laboratory reports.
Language of instruction: German
Teaching methods: Laboratory course supported by blackboard notes, transparencies and assisted practical work
Assessment methods: ☐ Written exam ☑ Presentation ☐
☐ Written assignment ☐ Project work ☑ Written laboratory reports
☐ Oral exam ☑ Practical exercises
Recommended reading: Operation manuals and laboratory instructions provided online (lecturer's homepage www.home.hs-karlsruhe.de/~wokl0001)

1.3.4 Electronics
Course title: Electronics
Course code: KI 3B330
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 4
Semester: 3rd semester
Name of the lecturer: Prof. Dr.-Ing. Rudolf Koblitz

Course contents: Electrical characteristics of semiconductor components such as diodes, bipolar and field effect transistors, and operational amplifiers. Bias-point calculations of Circuits containing semiconductor-components. Small-signal calculations of semiconductor circuits with one or several transistors. Non-ideal behaviour of operational amplifiers (transit frequency, slew rate)

Prerequisites: Knowledge of Electrical Engineering basics such as the Thévenin equivalent, superposition, linear networks, AC calculations. Basic knowledge in Mathematics.

Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:

- be able to understand smaller semiconductor circuits,
- be able to calculate transfer characteristics of semiconductor circuits,
- be able to calculate amplification factors, input resistances and Bode plots with the aid of small-signal calculations.

Language of instruction: German

Teaching methods: Lecture supported by transparencies, Power Point slides and PSPICE simulations

Assessment methods: ☒ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work
☐ Oral exam ☐ Practical exercises ☒

Recommended reading:
- U.Tietze, Ch.Schenk: Halbleiter-Schaltungstechnik, Springer-Verlag, 10.Auflage (oder higher)

1.3.5 Electronics Laboratory

Course title: Electronics Laboratory

Course code: KI 3B331

Type of course: Laboratory

Level of course: Bachelor

Degree Program: Communications Engineering and Information Technology

Year of study: Second year

ECTS Credits: 2

Semester: 3rd semester

Name of the lecturer: Prof. Dr.-Ing. Rudolf Koblitz

Course contents: PSPICE tutorial, calculation, simulation and measurement of different electronic circuits such as:
- Emitter-coupled pairs of npn bipolar Transistors,
- Transistor amplifiers: amplification, input resistance and total harmonic distortion.
- amplifiers with push-pull output stages.
Module

1.3.6 Stochastic Signals and Systems

Course title: Stochastic Signals and Systems
Course code: KI 3B340
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 6
Semester: 3rd semester
Name of the lecturer: Prof. Dr. J. Stöckle

Course contents: The aim of each engineer is to design technical products or technical processes in a somewhat optimal manner. The demands may be small energy consumption, a long lifetime, high precision, good reliability or the achievement of other properties. This aim can only be achieved by means of a highly systematic design process. At the beginning, a mathematical model of the product or the technical process has to be created. In order to get deep insight into the function of the respective product or the process, the model is examined intensively. By doing this, one gets optimum parameters for the realisation of the product or the process. Usually, the theoretical results are verified with the help of a computer simulation before they are converted into reality. In the lecture, the students are provided with knowledge on how technical processes (products) can be mathematically described and how they are systematically examined. The required
mathematical tools are discussed. The technical (and natural) world is described with the use of signals and systems.

In the first part of the lecture, the methods for working with determined analog signals are reviewed. Some key words are: linear differential equations, mathematical description of determined signals, generalised derivation, linear systems, Laplac -transforms, transfer function, frequency function, step response, impulse response, stability, Fourier series, total harmonic distortion (THD).

In the second part of the lecture, the emphasis is on some special properties of linear systems. Many signals show a stochastic character. Especially noise signals have an influence on the information transmission on Earth, be it via cable or air or between Earth and satellite. The mathematical methods for the description of stochastic signals are presented and the passage of stochastic signals through analog linear systems is discussed. Some keywords are: Fourier transforms, linear phase, minimum phase, group delay, probability density, random variable, expectation, random process, autocorrelation, power density, mean power, standard deviation, white noise, theorem of Wiener-Khinchine, estimation of expectation values.

Prerequisites: Basic knowledge of System Theory and Laplace transforms
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:
- be able to describe technical systems and signals by using mathematical methods,
- be able to optimise technical systems,
- be able to describe stochastic signals by using statistical methods,
- be able to design analog filters.

Language of instruction: German
Teaching methods: Lecture supported by lecture notes, transparencies and practical exercises.
Assessment methods: 🗒 Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐
### 1.4 Fourth Semester

#### 1.4.1 Digital Communications 1

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<th>Digital Communications 1</th>
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<tbody>
<tr>
<td>Course code</td>
<td>KI 4B410</td>
</tr>
<tr>
<td>Type of course</td>
<td>Lecture</td>
</tr>
<tr>
<td>Level of course</td>
<td>Bachelor</td>
</tr>
<tr>
<td>Degree Program</td>
<td>Communications Engineering and Information Technology</td>
</tr>
<tr>
<td>Year of study</td>
<td>Second year</td>
</tr>
<tr>
<td>ECTS Credits</td>
<td>4</td>
</tr>
<tr>
<td>Semester</td>
<td>4th semester</td>
</tr>
<tr>
<td>Name of the lecturer</td>
<td>Prof. Dr. Franz Quint</td>
</tr>
<tr>
<td>Course contents</td>
<td>After a review of some relevant topics of system theory, the course starts with the transformation of bandpass signals to complex basebands. Then, the structure of digital communication systems is discussed. Following the way of the signal through the system, the focus is directed to the main parts of the system: formatting, baseband transmission, transmission via bandlimited channels, equalisation, carrier modulation, demodulation, link budget.</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>Knowledge in Mathematics, System Theory, Probability, and Random Signals.</td>
</tr>
<tr>
<td>Course objectives</td>
<td>After having successfully completed the course, the students should:</td>
</tr>
<tr>
<td>expressed in learning</td>
<td>• know the structure and mode of operation of modern digital communication systems,</td>
</tr>
<tr>
<td>outcomes and</td>
<td>• know the techniques for single carrier modulation and demodulation,</td>
</tr>
<tr>
<td>competences</td>
<td>• be able to understand the requirements on a digital communication system and to choose appropriate methods for fulfilling these requirements.</td>
</tr>
<tr>
<td>Language of instruction</td>
<td>German</td>
</tr>
<tr>
<td>Teaching methods</td>
<td>Lecture supported by transparencies, Power Point slides and MATLAB simulations</td>
</tr>
<tr>
<td>Assessment methods</td>
<td>☒ Written exam</td>
</tr>
<tr>
<td></td>
<td>☐ Presentation</td>
</tr>
<tr>
<td></td>
<td>☐ Written assignment</td>
</tr>
<tr>
<td></td>
<td>☐ Project work</td>
</tr>
<tr>
<td></td>
<td>☐ Oral exam</td>
</tr>
<tr>
<td></td>
<td>☐ Practical exercises</td>
</tr>
</tbody>
</table>

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21
1.4.2 Digital Communications Laboratory

Course title: Digital Communications Laboratory
Course code: KI4B411
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 2
Semester: 4th semester
Name of the lecturer: Prof. Dr. Franz Quint
Course contents: Practical laboratory work on the following topics: random signals, spectrum analyser measurements, vector signal analyser measurements, modulation signals PSK, FSK, QAM, fax signals, ISDN protocols, PCM

Prerequisites: Knowledge in System Theory and Random Signals

Course objectives expressed in learning outcomes and competences:
- be able to perform measurements with the spectrum analyser and the vector signal analyser,
- know the protocols used in ISDN and fax data transmission.

Language of instruction: German
Teaching methods: Practical laboratory work supported by MATLAB simulations
Assessment methods: Written exam ☐ Presentation ☐ Written assignment ☐ Project work ☐ Oral exam ☒ Practical exercises ☐

Recommended reading:

1.4.3 RF Technology

Course title: RF Technology
Course code: KL4B420
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
Module

ECTS Credits: 6
Semester: 4th semester
Name of the lecturer: Prof. Dr. Hans A. Sapotta
Course contents:
• Historical overview
• Skin effect
• Lossy lumped elements, Q
• Resonance, bandwidth, insertion loss
• Crystals
• Transmission lines, characteristic impedance, wave propagation
• Matching transformers, Smith diagram
• Striplines
• Electromagnetic waves in free space, wave equation
• Hollow waveguides
• Antennas
• Active RF elements, diodes, bipolar transistors, FETs
• 2-port theory, stray parameters
• Electronic noise, noise figure, calculation methods
• Intermodulation, intercept points and their calculation

Prerequisites: Knowledge in Mathematics, System Theory, Probability, and Random Signals
Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:
• have lost their fear of RF technology,
• have learned to calculate circuits with lossy elements,
• be able to use crystals,
• understand the behaviour of transmission lines,
• understand the behaviour of electromagnetic waves in free space and in hollow waveguides,
• be able to use and build antennas,
• understand the behaviour of active elements in the field of RF,
• be able to calculate noise figures of circuits and systems,
• understand intercept points and their calculation.

Language of instruction: German
Teaching methods: Lecture supported by blackboard notes, Power Point slides, transparencies and calculations
Assessment methods: ✔ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐

Recommended reading:
Weitere Literatur:
## 1.4.4 Design of Digital Systems

**Course title:** Design of Digital Systems  
**Course code:** KI 4B430  
**Type of course:** Lecture  
**Level of course:** Bachelor  
**Degree Program:** Communications Engineering and Information Technology  
**Year of study:** Second year  
**ECTS Credits:** 4  
**Semester:** 4th semester  
**Name of the lecturer:** Prof. Dr.-Ing. Gerhard Schäfer  
**Course contents:** Digital systems are described on the basis of the combination of functional blocks like ALUs, sequencers or state machines. The design methods are described on the basis of optimisation methods for combinational and sequential circuits. Alternative logic representations, e.g. binary decision trees, will be presented. VHDL will be introduced to describe the behaviour of the circuit as well as structural aspects via generation techniques.

**Prerequisites:** Basic knowledge of digital circuits  
**Course objectives expressed in learning outcomes and competences:** After having successfully completed the course, the students should:

- be able to create a structural design based on functional blocks,  
- know the basic procedures of logic and state optimisation,  
- be able to write behavioural descriptions of functional blocks,  
- be able to create synthesisable VHDL codes.

**Language of instruction:** German  
**Teaching methods:** Lecture supported by transparencies, Power Point slides and program demonstrations  
**Assessment methods:**  
- [X] Written exam  
- [ ] Presentation  
- [ ] Written assignment  
- [ ] Project work  
- [ ] Oral exam  
- [ ] Practical exercises  

**Recommended reading:**  
- J. Reichardt, B. Schwarz, VHDL-Synthese, Entwurf digitaler Schaltungen und Systeme, Oldenbourg-Verlag, 2000  
- Bleck et al. Praktikum des modernen VLSI-Entwurfs, Teubner Verlag 1996  
- Molitor, Scholl, Datenstrukturen und effiziente Algorithmen für die Logiksynthese kombinatorischer Schaltungen, Teubner Verlag 1999  
1.4.5 VHDL Laboratory

Course title: VHDL Laboratory
Course code: KI 4B431
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 2
Semester: 4th semester
Name of the lecturer: Prof. Dr.-Ing. Gerhard Schäfer
Course contents: Digital systems will be described by means of the hardware description language VHDL. Combinatorial and sequential circuits (ALUs, sequencer, counters, bus structures . . . ) are described and synthesised to an evaluation board. The designs will be tested with the help of virtual test environments written in VHDL and physical signals on board level.

Prerequisites: Structure and behaviour of digital circuits

Course objectives expressed in learning outcomes and competences:
- be able to write and debug VHDL codes in a design environment,
- be able to create a structural design based on functional blocks,
- be able to program a FPGA on a board,
- know how to write and debug behavioural descriptions of functional blocks,
- be able to create synthesisable VHDL code.

Language of instruction: German

Teaching methods: Laboratory course with practical exercises and program applications

Assessment methods:
- Written exam
- Presentation
- Written assignment
- Project work
- Oral exam
- Practical exercises

Recommended reading:
- J. Reichardt, B. Schwarz, VHDL-Synthese, Entwurf digitaler Schaltungen und Systeme, Oldenbourg-Verlag, 2000
- Bleck et al. Praktikum des modernen VLSI-Entwurfs, Teubner Verlag 1996
- Molitor, Scholl, Datenstrukturen und effiziente Algorithmen für die Logiksynthese kombinatorischer Schaltungen, Teubner Verlag 1999,
- Scarpino, Frank, VHDL and AHDL Digital System Implementation, Prentice Hall 1998
1.4.6 Design of Analog Systems

Course title: Design of Analog Systems
Course code: KI 4B440
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 4
Semester: 4th semester
Name of the lecturer: Prof. Dr.-Ing. Rudolf Koblitz

Course contents: Based on the knowledge of the lecture "Electronics", this course gives a deeper insight into some selected topics of electronics. Namely, the following themes are treated:

- Bandgap reference
- Internal structure of bipolar and MOSFET Operational amplifiers
- Switch-mode power supply treated on the example of a buck converter
- Multiplier circuits (Gilbert cell)
- Transimpedance amplifiers

Prerequisites: Knowledge of the lecture "Electronics" (KI 3B330) and the "Electronics Laboratory" (KI 3B331), PSPICE

Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:

- be able to understand complex analog semiconductor circuits,
- be able to use PSPICE with the aim of analysing and optimising analogue circuits,
- have fundamental knowledge of state-of-the art analog functional modules (multipliers, amplifiers, switch-mode power supplies)

Language of instruction: German

Teaching methods: Lecture supported by transparencies, Power Point slides and PSPICE simulations

Assessment methods:
- Written exam
- Written assignment
- Project work
- Oral exam
- Practical exercises

Recommended reading:
P.Klein: Schaltungen und Systeme - Grundlagen, Analyse und Entwurfsmethoden, Oldenbourg-Verlag
Ulrich Schlienz: Schaltnetzteile und ihre Peripherie, Vieweg-Verlag, 2.Auflage
U.Tietze, Ch.Schenk: Halbleiter-Schaltungstechnik, Springer-Verlag, 10.Auflage (oder higher)
1.4.7 Laboratory on the Design of Analog Systems

Course title: Laboratory on the Design of Analog Systems
Course code: KI 4B441
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 2
Semester: 4th semester
Name of the lecturer: Prof. Dr.-Ing. Rudolf Koblitz

Course contents: The Laboratory on the Design of Analogue Systems gives a deeper insight into the topics covered in the lecture. The following circuits will be treated in detail. Fundamental interrelationships will be presented in additional PSPICE simulations. The following topics are dealt with:

- Bandgap reference cell with bipolar transistors or diodes
- Bipolar operational amplifiers
- Amplifiers with different field effect transistors
- Buck converters (DC-DC-step-down-converters)

Prerequisites: Knowledge of the lecture "Electronics" (KI 3B330) and the "Electronics Laboratory" (KI 3B331), PSPICE, participation in the lecture KI 4B440 accompanying this laboratory course.

Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:

- understand the internal structure of operational amplifiers and frequency compensation,
- have fundamental knowledge of switch-mode power supplies,
- know about bandgap voltage references and applications.

Language of instruction: German

Teaching methods: Lecture supported by transparencies, Power Point slides and PSPICE simulations

Assessment methods: □ Written exam □ Presentation □
□ Written assignment □ Project work □
□ Oral exam □ Practical exercises □

Recommended reading:
P.Klein: Schaltungen und Systeme - Grundlagen, Analyse und Entwurfsmethoden, Oldenbourg-Verlag
Ulrich Schlienz: Schaltzeugteile und ihre Peripherie, Vieweg-Verlag, 2.Auflage
1.4.8 Control Theory

Course title: Control Theory
Course code: Kl4B450
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Second year
ECTS Credits: 4
Semester: 4th semester
Name of the lecturer: Prof. Dr. Urban Brunner

Course contents:
- Mathematical description of linear systems, state space models and transfer functions
- Modelling in control engineering, qualitative characteristics of real processes, identification of particular parameters
- System analysis: stability criteria (Nyquist), robustness, transient behaviour and steady state.
- Classical control methods: loop gain shaping, lead lag compensators, root locus techniques
- Design and configuration of PID controllers
- Cascaded control loops, feed-forward control and discontinuous control

Prerequisites: System Theory
Course objectives expressed in learning outcomes and competences:
- understand why automatic control is useful in Electrical Engineering,
- know key ideas and concepts: dynamics and feedback,
- be able to mathematically describe real processes,
- be able to recognise when a process is easy or difficult to control,
- know relevant mathematical theories,
- be able to solve simple control problems,
- be able to use the relevant computational tools.

Language of instruction: German
Teaching methods: Lecture supported by transparencies and Power Point slides

Assessment methods:
- Written exam
- Written assignment
- Oral exam
- Presentation
- Project work
- Practical exercises

Recommended reading:
1.4.9 Computer-aided Control System Design

Course title: Computer-aided Control System Design  
Course code: KI4B451  
Type of course: Laboratory  
Level of course: Bachelor  
Degree Program: Communications Engineering and Information Technology  
Year of study: Second year  
ECTS Credits: 2  
Semester: 4th semester  
Name of the lecturer: Prof. Dr. Urban Brunner  
Course contents: This course is mandatory for students attending the course KI4B450 "Control Theory". By performing practical exercises, students should apply their knowledge to simulated and/or real processes in order to deepen their knowledge and enhance their experiences with industrial equipment and tools.

Topics:
- Repetition of MATLAB basics and introduction to MATLAB Control System Toolbox
- Design of PID controllers by using MATLAB
- Modelling and control of a DC servo system (servo dilemma)
- Advanced features in PID tuning: gain scheduling, avoiding integral windup, cascaded PIDs, PIDs with feed-forward

Prerequisites: System Theory, Control Theory

Course objectives expressed in learning outcomes and competences: 
- After having successfully completed the course, the students should:
  - be able to solve control problems by using MATLAB,
  - understand the windup phenomenon and know anti-windup compensation,
  - be able to tune and optimise PID controllers.

Language of instruction: German

Teaching methods: Laboratory course supported by MATLAB simulations and demonstrations in the control laboratory

Assessment methods: 
- Written exam
- Written assignment
- Oral exam
- Presentation
- Project work
- Practical exercises

Recommended reading:
1.5 Sixth Semester

1.5.1 Digital Communications II

Course title: Digital Communications II
Course code: KI 6B610
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Third year
ECTS Credits: 5
Semester: 6th semester
Name of the lecturer: Prof. Dr. Manfred Litzenburger
Course contents:
• Signal processing technologies in transmission systems
• Optimum receivers
• Carrier and symbol synchronisation
• Multiple-access methods
• Spread-spectrum techniques (CDMA)
• Multi-carrier techniques (OFDM)

Prerequisites: Knowledge in Systems Theory and Communication Technology
Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:
• understand the design criteria of a digital communication system,
• understand the structure of modern digital communication systems as well as the methods applied in their basic building blocks,
• know the principles of advanced broadband schemes like spread-spectrum and multi-carrier transmission and their application,
• be able to design, dimension and assess a digital communication system.

Language of instruction: German
Teaching methods: Lecture supported by transparencies and simulation examples
Assessment methods: 
- Written exam
- Written assignment
- Oral exam
- Practical exercises

Recommended reading:

1.5.2 Mobile Communication Systems

Course title: Mobile Communication Systems
Course code: KI 6B611
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Third year
ECTS Credits: 3
### Module 31

**Semester:** 6th semester  
**Name of the lecturer:** Prof. Dr. Manfred Litzenburger  
**Course contents:**
- Principles of mobile radios  
- Cellular systems  
- The mobile radio channel  
- Architectures and infrastructure of mobile radio systems  
- Support of mobility  
- Packet data transmission  
- 2nd generation mobile systems (GSM, GPRS)  
- 3rd generation mobile systems (UMTS, HSPA)  
- Beyond 3G - Long Term Evolution (LTE)  
- Non-cellular systems (WLANs, Bluetooth)

**Prerequisites:** Knowledge in System Theory and Communication Technology

**Course objectives expressed in learning outcomes and competences:**
- understand the basic principles of mobile communication systems, such as the cellular concept, mobile radio transmission and network architectures for mobility support,  
- be able to analyse the building blocks of a mobile radio system, especially with regard to data transmission,  
- know the specific implementations in today’s systems like GSM/GPRS and UMTS/HSPA,  
- know the current and future trends towards 4G mobile radio systems.

**Language of instruction:** German  
**Teaching methods:** Lecture supported by transparencies and simulation examples  
**Assessment methods:** ☒ Written exam  
☐ Oral exam  
☐ Project work  
☐ Practical exercises  
**Recommended reading:**

### 1.5.3 Algorithms and Data Structures

**Course title:** Algorithms and data structures  
**Course code:** KI 6B620  
**Type of course:** Lecture  
**Level of course:** Bachelor  
**Degree Program:** Communications Engineering and Information Technology  
**Year of study:** Third year  
**ECTS Credits:** 6  
**Semester:** 6th semester  
**Name of the lecturer:** Prof. Dr.-Ing. Gerhard Schäfer  
**Course contents:** Communication systems consist of a combination of hardware and software components. Standard software algorithms will be shown in the context of communication-based problems. The algorithms are handling sorting problems, tree, graph and coding algorithms as well as textual input.
processing. In a software project, the students learn about problem structuring methods, the use of complex data structures and the application of certain standard algorithms.

Prerequisites: C/C++ programming, object-oriented programming OOP

Course objectives expressed in learning outcomes and competences:

- be able to structure a complex problem into functional blocks,
- know the use and application of standard algorithms,
- be able to program and debug complex algorithms in C++,
- be able to create and write significant test cases.

Language of instruction: German

Teaching methods: Lecture supported by transparencies, Power Point slides, program demonstrations and project work

Assessment methods: Written exam, Presentation, Written assignment, Project work, Oral exam, Practical exercises

Recommended reading:
- Paul Molitor, Christoph Scholl, „Datenstrukturen und effiziente Algorithmen für die Logiksynthese kombinatorischer Schaltungen“, Verlag B.G. Teubner
- Bjarne Stroustrup, „Die C++ Programmiersprache“, Verlag Addison-Wesley, 1998
- Robert Sedgewick, „Algorithmen in C++“, Verlag Addison-Wesley, 1999
- Harald Reß, Günther Viebeck, „Datenstrukturen und Algorithmen“, Verlag Hanser, 2000
- Alfred Aho et. al., „Compilerbau Teil 1“, Verlag Oldenburg, 2005

1.5.4 Introduction to Bus Systems

Course title: Introduction to Bus Systems
Course code: N6B622
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Third year
ECTS Credits: 2
Semester: 6th semester
Name of the lecturer: Prof. Dr. M. Katz

Course contents:
- Introduction to industrial field busses
- ISO/OSI model for field busses
- Protocols, medium access control techniques
- Implementation of protocols
- Interfaces to the medium and to the application
- Real-time efforts in bus technology
- By means of examples, the following concrete fieldbus families are discussed: PROFIBUS/PROFINET, FF, HART, CAN, AS-Interface

Prerequisites: Basic technical skills in Communication Technology

Course objectives expressed in learning outcomes and competences:

- know the fundamental architecture of a fieldbus system,
- know the fundamental concepts of PROFIBUS/PROFINET, FF,
HART, CAN-Bus, AS-Interface,
- know the structure of the IEC Standard 61158.

**Language of instruction:** German

**Teaching methods:** Lecture supported by blackboard notes, beamer presentations and practical exercises

**Assessment methods:**
- [ ] Written exam
- [ ] Presentation
- [ ] Written assignment
- [ ] Project work
- [ ] Oral exam
- [ ] Practical exercises

**Recommended reading:**
- Field buses for Process Control, ISA- The Instrumentation, Systems and Automation Society, Jonas Berge ISBN 1-55617-760-7
- CAN Controller Area Network, Grundlagen und Praxis, Wolfhard Lawrenz, Hüthig ISBN 3-7785-2575-1
- Industrial Communication Technology Handbook, CRC Press, Richard Zurawski

### 1.5.5 Digital Signal Processing

**Course title:** Digital Signal Processing

**Course code:** KI 6B630

**Type of course:** Lecture

**Level of course:** Bachelor

**Degree Program:** Communications Engineering and Information Technology

**Year of study:** Third year

**ECTS Credits:** 4

**Semester:** 6th semester

**Name of the lecturer:** Prof. Dr. J. Stöckle

**Course contents:** Many achievements of our modern technical environment could only be realised by making intensive use of digital signal processing methods. Mobile communication, laser printer control, medical ultrasound equipment or robotic control are only a few examples. Digital signal processing (DSP) was developed from the classical linear system theory with regard to sampled signals. Powerful microprocessors or specialised signal processors are used for realising the mathematical algorithms of digital signal processing. In the lecture, the following basics of DSP are presented: sampling signals, discrete systems, transfer function, step response, difference equations, Z-transforms, FFT, minimum phase and minimum delay, frequency response, and stability. Furthermore, the students are provided with an overview on the main design methods for digital filters, such as bilinear transformation, the method of impulse invariance, and optimum design procedures for IIR and FIR filters using the Gaussian least squares method.

**Prerequisites:** Advanced Mathematics 1-3, System Theory, Stochastic Systems and Signals

**Course objectives expressed in learning outcomes and competences:**
- be able to design digital filters,
- be able to develop new design procedures for digital filters,
- be able to design systems for digital signal processing.

**Language of instruction:** German

**Teaching methods:** Lecture supported by lecture notes, transparencies and practical exercises.
Module

1.5.6 Digital Signal Processors

Course title: Digital Signal Processors
Course code: KI 6B631
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Third year
ECTS Credits: 2
Semester: 6th semester
Name of the lecturer: Prof. Dr. Franz Quint

Course contents: After a brief explanation of the architecture and characteristics of digital signal processors, the focus of this lecture is on programming real-time applications and the implementation of typical algorithms in digital signal processing, such as filtering, the generation of sinusoids etc. The usage of interrupts, DMA and serial ports is an important topic.

Prerequisites: Knowledge in Digital Signal Processing.

Course objectives expressed in learning outcomes and competences:

- be able to choose the signal processor which suits the needs of the application,
- be able to implement DSP algorithms on the processor, to profile them and to get them working in real time.

Language of instruction: German

Teaching methods: Lecture supported by Power Point slides and practical signal processor programming exercises.

Assessment methods: ☒ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work
☐ Oral exam ☐ Practical exercises ☐


1.5.7 Power Electronics

Course title: Power Electronics
Course code: KI 6B640
Type of course: Lecture

Bateman, Andrew: The DSP handbook : algorithms, applications and design techniques, Prentice Hall, Harlow, 2002
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Third year
ECTS Credits: 6
Semester: 6th semester
Name of the lecturer: Prof. Dr.-Ing. Alfons Klönne

Course contents:
- Introduction to Power Electronics
- Overview of power semiconductor switches (diodes, thyristors, GTO, BJT, Mosfet)
- Drive and snubber circuits
- Structure of power module packages the heat transfer
- DC-DC switch-mode converters (step-down converters, step-up converters, buck-boost converters, fly-back converters)
- Line-frequency phase-controlled rectifiers and inverters (single-phase, three-phase)
- Switch-mode inverters (single-phase, three-phase)
- Concepts of current control in switch-mode inverters
- Variable frequency inverters
- Vector control of three-phase inverters

Prerequisites: Basic knowledge in Electrical Engineering 1, Basic Electrical Engineering 2, and Electronics

Course objectives expressed in learning outcomes and competences:
- have profound knowledge of power electronic switches, their drive and protection,
- have fundamental knowledge of generic power electronic circuits,
- be able to analyse and calculate fundamental switched-power supplies,
- understand line-frequency phase controlled rectifiers and inverters,
- be acquainted with practical converter design,
- be able to apply basic control strategies in power electronic systems.

Language of instruction: German
Teaching methods: Lecture supported by practical exercises
Assessment methods: ☒ Written exam ☐ Presentation ☐
☒ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐

Recommended reading:
Anke, Dieter: Leistungselektronik, Oldenbourg, Berlin, 2000

1.5.8 Electromagnetic Compatibility (EMC)

Course title: Electromagnetic Compatibility (EMC)
Course code: KI6B641
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Third year
ECTS Credits: 2
Semester: 6th semester
Name of the lecturer: Prof. Dr.-Ing. Günter Langhammer
Course contents:

- Terminology, standards
- Impulses in the time and frequency domain
- Basics of coupling mechanisms in electric circuits
- Sources of disturbances
- Grounding and earthing
- Shielding
- Filters
- Handling of EMC problems
- Overvoltage protection

Prerequisites: Good knowledge of Physics and Electrical Engineering fundamentals
Course objectives expressed in learning outcomes and competences:

- be able to understand and use the correct terminology in the field of EMC
- be able to evaluate impulses in the time and frequency domain
- know the basic of coupling mechanisms in electric circuits
- know the most important sources of disturbances
- know the basics about grounding and earthing
- know the mechanism of shielding and different properties of shielding materials
- be able so select adequate filters for EMC-problems
- be able to choose adequate measures to treat EMC-problems
- know the different types of overvoltage protecting devices, their properties and application

Language of instruction: German
Teaching methods: Lecture supported by transparencies and practical exercises
Assessment methods: 
  - Written exam
  - Oral exam
  - Written assignment
  - Project work
  - Presentation
  - Practical exercises

Recommended reading:

1.5.9 Project Work
Course title: Project Work
Course code: KI6B650
Type of course: Project
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Third year
ECTS Credits: 8
Semester: 6th semester
Name of the lecturer: All professors from the Department of EIT
Course contents: The students form small groups to organise and implement a project according to ISO9000.

Prerequisites: Modules of semester 1 - 4

Course objectives expressed in learning outcomes and competences:

- be able to establish a specification,
- be able to structure a project,
- be able to establish a time table,
- be able to hold team discussions with minute keeping,
- be able to present their results.

Language of instruction: German

Teaching methods: After a brief introduction, the students autonomously work on their project. The status of the project is to be discussed with the lecturer on a regular basis.

Assessment methods: [ ] Written exam [x] Presentation [ ]
[x] Written assignment [x] Project work [ ]
[ ] Oral exam [ ] Practical exercises [ ]

1.6 Seventh Semester

1.6.1 Processing of Multidimensional Signals

Course title: Processing of Multidimensional Signals
Course code: KI 7B710
Type of course: Lecture
Level of course: Bachelor
Degree Program: Communications Engineering and Information Technology
Year of study: Fourth year
ECTS Credits: 2
Semester: 7th semester
Name of the lecturer: Prof. Dr. Franz Quint

Course contents: The general topic of this course is the processing of multidimensional signals, with a specific focus on image processing. Special attention is given to signal theory playing a role in image processing operations. The course covers the following topics: image acquisition, colour, point operations, geometrical transforms, interpolation, filtering, image transforms, morphology, and segmentation.

Prerequisites: Knowledge in Mathematics and Signal Processing

Course objectives expressed in learning outcomes and competences:

After having successfully completed the course, the students should:

- be able to set up an image acquisition system and choose the adequate camera and geometrical setup,
- be able to develop and to apply image processing operations.

Language of instruction: German

Teaching methods: Lecture supported by PowerPoint slides and MATLAB simulations
Assessment methods:

- Written exam
- Written assignment
- Oral exam
- Presentation
- Project work
- Practical exercises

Recommended reading:


1.6.2 Leadership

Course title: Leadership
Course code: KI 7B720
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Fourth year
Module

| ECTS Credits: | 3 |
| Semester: | 7th semester |
| Name of the lecturer: | Prof. Dr. Grimm |
| Course contents: | Theories and models: Definition of leadership, the management circle; scientific management; the human relations movement; the trait theory of leadership; the situational approach. Prerequisites for individual leadership: Understanding inter- and intra-individual differences, relevant personality attributes, typologies; individual-oriented leadership behavior. Leadership tasks: Informing and communicating, motivation, conflict solving, setting objectives, task planning, decision and delegation, checking on progress, positive and negative reinforcement. Group work: The advantages of teamwork and avoiding negative effects on the performance |
| Prerequisites: | - |
| Course objectives expressed in learning outcomes and competences: | After having successfully completed the course, the students should: |
| | • be able to understand and evaluate research on leaders and leadership, |
| | • know the most recent leadership theories and their practical realisations, |
| | • have improved their leadership qualities, |
| | • be enabled to enhance their knowledge by means of continuous workplace learning. |
| Language of instruction: | German |
| Teaching methods: | Lecture with interactive methods of instruction such as case studies and teamwork |
| Assessment methods: | ❑ Written exam ❑ Presentation ❑ |
| | ❑ Written assignment ❑ Project work ❑ |
| | ❑ Oral exam ❑ Practical exercises ❑ |

1.6.3

1.6.4 Business Administration

| Course title: | Business Administration |
| Course code: | N7B721 |
| Type of course: | Lecture |
| Level of course: | Bachelor |
| Degree Program: | Communications Engineering and Information Technology |
| Year of study: | Fourth year |
| ECTS Credits: | 3 |
| Semester: | 7th semester |
| Name of the lecturer: | Prof. Mayer |
| Course contents: | Economic basics: productivity, factors of production, characteristics of |
companies. Management basics: business objectives, strategic and operational planning, decision making, leading and controlling processes and organizations. Legal forms of companies, entrepreneurship, a company's organisation, the annual financial statement - a company's business card, balance sheet, income statement, controlling and managing via performance indicators

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<th>Prerequisites:</th>
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<tr>
<td>Course objectives expressed in learning outcomes and competences:</td>
<td>After having successfully completed the course, the students should:</td>
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<td></td>
<td>• possess basic management knowledge.</td>
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<td>Language of instruction:</td>
<td>German</td>
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<td>Teaching methods:</td>
<td>Lecture supported by Power Point slides, exercises and group work</td>
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<td>Assessment methods:</td>
<td>☑ Written exam ☐ Presentation</td>
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<td>☐ Written assignment ☐ Project work</td>
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<td>☐ Oral exam ☐ Practical exercises</td>
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<td>Script and Documents of the Lecturer</td>
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