Module Handbook

Bachelor’s Program:

Energie- und Automatisierungstechnik
(Energy and Automation Technology)

Bachelor of Engineering

Stand: 30.10.2008
1. Module

1.1 First Semester

1.1.1 Mathematics I

Course title: Mathematics 1
Course code: E 1B110
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 6 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr. Jürgen Weizenecker
Course contents:
- Analytic Geometry in Space
- Linear Algebra
- Basic concepts of mathematics (sets, logic, statements, proof rules)
- Numbers (real, complex)
- simple equations and inequations
- Sequences and convergence
- Limit of Sequences
- Mapping and Functions with one variable only
- Introduction of 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:
  - handle correctly the basic mathematical concepts introduced
  - be able to solve basic problems in the above areas
  - be able to transfer the concepts to engineering problems

Language of instruction: German
Teaching methods: Blackboard
Assessment methods:
- Written exam
- Written assignment
- Oral exam

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
Course code: E 1B121
Type of course: Lecture
Level of course: Bachelor
### Module 3

**Degree Program:** Energy and Automation Technology  
**Year of study:** First year  
**ECTS Credits:** 3 CP  
**Semester:** 1. semester  
**Name of the lecturer:** Prof. Dr. Manfred Strohrmann, 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:** After having successfully completed the course, the students should:  
- be able to handle physical equations with units of measurements  
- know the basic principles of electricity  
- understand the fundamental interrelations of 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  
- Written assignment  
- Oral exam  
- Project work  
- Practical exercises  
**Recommended reading:**  

### 1.1.3 Fields

**Course title:** Fields  
**Course code:** EB1B122  
**Type of course:** Lecture  
**Level of course:** Bachelor  
**Degree Program:** Energy and Automation Technology  
**Year of study:** First year  
**ECTS Credits:** 3 CP  
**Semester:** 1. semester  
**Name of the lecturer:** Prof. Dr. Thomas Köller  
**Course contents:**  
- basics, electrical charge, voltage, electrical fieldstrength  
- calculation of electrical fields  
- capacity  
- forces in electrical fields  
- magnetic fields  
- calculation of magnetic fields
Prerequisites:
- 
Course objectives expressed in learning outcomes and competences:
- have detailed knowledge on electrical and magnetic fields
- be able to make use of Maxwell's equations

Language of instruction: German

Teaching methods:
- lecture with beamer and power point presentation, transparencies and using blackboard

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 Physics

Course title: Physics
Course code: E1B150
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 4 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr. Harald Sehr

Course contents:
Halliday/Resnick/Walker: Fundamental of Physics
Chapter 1-12, 16
Kinetics, Forces, Conservation laws of energy and momentum, rotation, oscillations.

Prerequisites:
- 
Course objectives expressed in learning outcomes and competences:
- Basic physical and technical understanding

Language of instruction: German

Teaching methods:
- lecture, practical exercises, web based e-learning system, online webinar, online tests

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

Recommended reading:
Halliday/Resnick/Walker: Fundamental of Physics
1.1.5 Information Technology 1

Course title: Information Technology 1
Course code: E1B140
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 6 CP
Semester: 1. 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
- process of program development: 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 memory, stack and heap
- indexing and addressing

Prerequisites: Basic technical skills for using a PC
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: blackboard notes, overhead projector slides, beamer presentation of examples, practical programming exercises
Assessment methods: ☒ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work
☐ Oral exam ☒ Practical exercises ☐

Recommended reading:
D. Louis, C/C++ Kompendium, Markt und Technik Verlag, München
D. Louis, C/C++ Referenz, Markt und Technik Verlag, München
ANSI C 2.0, Grundlagen Programmierung, Herdt-Verlag
### 1.1.6 Engineering mechanics

<table>
<thead>
<tr>
<th>Course title:</th>
<th>Engineering mechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course code:</td>
<td>E1B131</td>
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<tr>
<td>Type of course:</td>
<td>Lecture</td>
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<tr>
<td>Level of course:</td>
<td>Bachelor</td>
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<td>Degree Program:</td>
<td>Energy and Automation Technology</td>
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<tr>
<td>Year of study:</td>
<td>First year</td>
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<td>ECTS Credits:</td>
<td>6 CP</td>
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<tr>
<td>Semester:</td>
<td>1. semester</td>
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<tr>
<td>Name of the lecturer:</td>
<td>Dipl.-Ing. Elfi Brandenburger</td>
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<tr>
<td>Course contents:</td>
<td>Engineering statics, Mechanics of materials and elastic deformation, kinematics and kinetics</td>
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<tr>
<td>Prerequisites:</td>
<td>basic know how in mathematics</td>
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<tr>
<td>Course objectives</td>
<td>After having successfully completed the course, the students should:</td>
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<tr>
<td>expressed in learning outcomes and competences:</td>
<td>• basic knowledge of engineering mechanics at theory and practice to estimate and calculate the action of forces to solid state materials</td>
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<tr>
<td>Language of instruction:</td>
<td>German</td>
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<tr>
<td>Teaching methods:</td>
<td>lectures and exercises</td>
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<tr>
<td>Assessment methods:</td>
<td>❑ Written exam</td>
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<td></td>
<td>❑ Oral exam</td>
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<td></td>
<td>❑ Practical exercises</td>
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### 1.1.7 Materials of Electrical Engineering

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<tr>
<th>Course title:</th>
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<tr>
<td>Course code:</td>
<td>E1B132</td>
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<td>Type of course:</td>
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<td>Degree Program:</td>
<td>Energy and Automation Technology</td>
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<td>Year of study:</td>
<td>First year</td>
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<td>ECTS Credits:</td>
<td>2 CP</td>
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<tr>
<td>Semester:</td>
<td>1. semester</td>
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<tr>
<td>Name of the lecturer:</td>
<td>Prof. Dr. Juliane Stölting</td>
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<tr>
<td>Course contents:</td>
<td>Structure of Materials, Metals, Alloys, Polymers, Method of Testing, Manufacture and Treatment of Materials</td>
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<td>Prerequisites:</td>
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<td>Course objectives</td>
<td>After having successfully completed the course, the students should:</td>
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<tr>
<td>expressed in learning outcomes and competences:</td>
<td>• have Knowledge of Properties of Materials for Electrical Engineering</td>
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<td>Language of instruction:</td>
<td>German</td>
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1.2 Second Semester

1.2.1 Mathematics 2

Course title: Mathematics 2
Course code: E 2B210
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 6 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Jürgen Weizenecker

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:
- handle correctly the basic mathematical concepts introduced
- be able to solve basic problems in the above areas
- be able to transfer the concepts to engineering problems

Language of instruction: German
Teaching methods: Blackboard
Assessment methods: ☒ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐

Recommended reading:
Westeermann, 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: E2B221
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 4 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Alfons Klönne
Course contents:
- Sinusoidal inputs and their representations
- Instantaneous, Average, and RMS Values
- Impedance and Series RLC Circuits
- Admittance and Parallel RLC Circuits
- Transfer Function of RLC Circuits
- Bode diagram
- Power in AC circuits
- Resonance
- Three-Phase circuits

Prerequisites: Basic Electrical Engineering 1

Course objectives expressed in learning outcomes and competences:
- be able to describe AC Circuits under steady state condition
- be endowed with the transfer function of AC circuits
- understand and apply Bode diagrams
- know the criteria of resonant circuits
- have learned to calculate the power in AC circuits and Three-Phase circuits

Language of instruction: German
Teaching methods: Lectures and exercises
Assessment methods:
- [x] Written exam
- [ ] Presentation
- [ ] Written assignment
- [ ] Project work
- [ ] Oral exam
- [ ] Practical exercises

Recommended reading:

1.2.3 Laboratory Basics Electrical Engineering

Course title: Laboratory Basics Electrical Engineering
Course code: E2B222
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 2 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Manfred Stohrmann
Module

Course contents:
- Voltage and current sources, measuring with multi-meters
- Stabilization of voltages
- Basic circuits with operation amplifier
- RC-Filter applications
- Resonance interpretation in RLC networks

Prerequisites:
Successful test in DC circuits

Course objectives expressed in learning outcomes and competences:
- be able to work with multi-meters and oscilloscopes
- have improved the knowledge about electric circuits
- be able to set-up electrical circuits
- be able to interpret test results

Language of instruction: German

Teaching methods: Experiments in laboratory
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

Course title: Microcontroller
Course code: E2B231
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 6 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Jürgen Gentner

Course contents: Students are to be put into situations where they have to come up with the optimal solution to concrete, real life problems. This usually involves to decide, in the first instance, whether or not a microcomputer system would be appropriate, including the type of components and structure.

In the process, students are expected to acquire detailed knowledge relating to the "embedded control" field (microcontroller based on 8051), primarily through the lecture as well as programming and testing of such a system in the microcontroller lab.

Prerequisites: Basics of computer science and electrical engineering

Course objectives expressed in learning outcomes and competences:
- the microprocessor and its internal functional elements (register, ALU, flags and instruction cycles)
- the external components: Data-/addressbus, different types of memory and the principles of realization, peripheral controllers (DMA-, interrupt-, I/O-, timer-/counter- and serial interface controller, type of RS 232)
- general microcomputer system features and optimization strategies (multi master systems, comparison of RISC and CISC processors,
instruction queue, pipelining, cache memory, Harvard architecture

Language of instruction: German
Teaching methods: Lecture supported by Power Point Slides
Assessment methods:
- Written exam
- Presentation
- Written assignment
- Project work
- Oral exam
- Practical exercises

Recommended reading:
Prof. Dr.-Ing. Gentner: Lecture notes "Microcontroller" (download area)
Bermbach, Rainer: Embedded Controller, Hanser-Verlag, 2001
SIEMENS C500 User's Manual (im Intranet der FH verfügbar)
Schaaf, Bernd-Dieter, Mikrocomputertechnik, Hanser-Verlag, 1999

### 1.2.5 Microcontroller

Course title: Microcontroller
Course code: E2B232
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 2 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Jürgen Gentner

Course contents: Approximately five weeks following the start of the semester the microcontroller lab accompanying the lecture begins. This lab continues in parallel with the lecture. The lab provides 12 work spaces for two students each. It is designed to allow students to program a microcontroller system with C517 such as to solve typical, hardware-related problems in the embedded control field, in an environment as close to real life as possible. To this end, the lab provides a professional developing environment (editor, assembler, simulator and remote debugger).

Prerequisites: Basics of computer science and electrical engeneering

Course objectives expressed in learning outcomes and competences:
- the microprocessor and its internal functional elements (register, ALU, flags and instruction cycles)
- the external components: Data-/addressbus, different types of memory and the principles of realization, peripheral controllers (DMA-, interrupt-, I/O-, timer-/counter- and serial interface controller, type of RS 232)
- general microcomputer system features and optimization strategies (multi master systems, comparison of RISC and CISC processors, instruction queue, pipelining, cache memory, Harvard architecture)

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

Recommended reading:
Prof. Dr.-Ing. Gentner: Lecture notes "Microcontroller" (download area)
1.2.6 Information Technology 2

Course title: Information Technology 2
Course code: E2B240
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: First year
ECTS Credits: 6 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. M. Katz, Prof. Dr. K. Wolfrum

Course contents:
- 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:
- know elaborate methods for program development
- be able to implement a given task to a well structured algorithm avoiding side effects
- be familiar with object oriented programming techniques like inheritance, overloading and the programming language C++

Language of instruction: German

Teaching methods:
blackboard notes, overhead projector slides, beamer presentation of examples, 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: E3B311, E3B312
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 6 CP
Semester: 3. semester
Name of the lecturer: Prof. Dr. Jürgen Weizenecker

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:
- handle correctly the basic mathematical concepts introduced
- be able to solve basic problems in the above areas
- be able to transfer the concepts to engineering problems
- be able to make use of the software package MATLAB
- handle numerical problems

Language of instruction: German
Teaching methods: Blackboard, Beamer presentation
Assessment methods:
- Written exam
- Written assignment
- Oral exam
- Presentation
- Project work
- 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 Technique

Course title: Measurement Technique
Course code: E3B321
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 4 CP
Semester: 3. semester
Name of the lecturer: Prof. Dr. Klaus Wolfrum
Course contents:
- units and dimensions
- systematic and statistic errors and error propagation, effect of noise
- electromechanical instruments
- current and voltage sensing using transducers and transformers
- signal conditioning with operational amplifiers
- digital data acquisition, digital analog and analog digital converters
- analog and digital storage oscilloscopes
- examples for measuring non electric quantities, e.g. temperature

Prerequisites: Fundamentals of electrical engineering
direct current, alternating current, electric and magnetic fields
Mathematics 1, Mathematics 2
Course objectives expressed in learning outcomes and competences:
- 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 using statistical methods of error propagation
- be aware of the prerequisites and limitations of digital signal acquisition, i.e. aliasing, quantization errors etc.

Language of instruction: German
Teaching methods: blackboard notes, overhead projector slides, beamer presentation, presentation of simulation examples
Assessment methods: Written exam, Written assignment, Oral exam
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 Technique Laboratory
Course code: E3B322
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Module 14

Year of study: Second year
ECTS Credits: 2 CP
Semester: 3. semester
Name of the lecturer: Prof. Dr. Klaus Wolfrum
Course contents: Laboratory work accompanying the course Measurement Technique
- analog oscilloscope applications
  viewing and characterizing elementary signals, trigger modes
  y-t and x-y operational modes
- digital storage oscilloscope
  viewing and characterizing elementary signals using implemented
  mathematical functions, characterization of harmonics using FFT
- computer aided temperature measurement on a heat sink mounted
  power transistor, characterization of thermal resistance etc.
- basic properties of operational amplifiers
- amplifier circuits for signal conditioning
- simulation of digital analog and analog digital converters using
  PSPICE

Prerequisites: Accompanying lecture Measurement Technique 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
  setting up analog and digital oscilloscopes
- be able to set up and use measurement systems
- be experienced in estimating possible error sources
- be experienced writing concise laboratory reports

Language of instruction: German
Teaching methods: blackboard notes, overhead projector slides, assistance during practical work
Assessment methods: [ ] Written exam [ ] Presentation
[ ] Written assignment [ ] Project work [x] Written laboratory reports
[ ] Oral exam [x] 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: E3B332
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 4 CP
Semester: 3. semester
Name of the lecturer: Prof. Dr. Rudolf Koblitz
Course contents:
- short review of fundamentals
- properties of semiconductors, pn-junction, diode
- basic properties of the bipolar transistor
- small signal and large signal applications of bipolar transistors
- optoelectronic components
- field effect transistors, junction FET, MOSFETs
- heat dissipation
- worked out examples for analog circuits
- operational amplifier

**Prerequisites:**
Fundamentals of electrical engineering
direct current, alternating current, electric and magnetic fields
Mathematics 1, Mathematics 2

**Course objectives expressed in learning outcomes and competences:**
After having successfully completed the course, the students should:
- know properties of semiconductor components
- be familiar with discrete electronic circuits
- be able to design adequate circuits for a given purpose
- be aware of the limitations of electronic circuits, i.e. heat dissipation, noise, distortion etc

**Language of instruction:**
German

**Teaching methods:**
blackboard notes, overhead projector slides, beamer presentation, presentation of simulation examples

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

**Recommended reading:**
U. Tietze, Ch. Schenk, E. Gamm, Electronic Circuits, Springer Verlag, Berlin,
A. S. Sedra, K. C. Smith, Microelectronic Circuits, Oxford University Press
E. Hering, K. Bressler, J. Gutekunst, Elektronik für Ingenieure, Springer Verlag, Berlin
P. Horowitz, W. Hill, The Art of Electronics, Cambridge University Press,

### 1.3.5 Electronics Laboratory

**Course title:** Electronics Laboratory

**Course code:** E3B332

**Type of course:** Laboratory

**Level of course:** Bachelor

**Degree Program:** Energy and Automation Technology

**Year of study:** Second year

**ECTS Credits:** 4 CP

**Semester:** 3. semester

**Name of the lecturer:** Prof. Dr. Rudolf Koblitz

**Course contents:** Laboratory work accompanying the course Electronics
emphasis on simulation electronic circuits before practical testing

- introductory examples for circuit simulation using PSPICE,
- RC lowpass, highpass, time domain and frequency domain simulation
- bias point of small signal amplifiers using bipolar transistors
- time and frequency domain behavior of small signal amplifiers
- differential amplifier
- complementary push-pull power amplifier

**Prerequisites:** Accompanying lecture Electronics and prerequisites mentioned there
Course objectives expressed in learning outcomes and competences:

- be familiar with circuit simulation using PSPICE
- be able to set up and test electronic circuits
- be experienced in estimating possible error sources
- be experienced writing concise laboratory reports

Language of instruction: German

Teaching methods: blackboard notes, overhead projector slides, assistance during practical work

Assessment methods:
- [x] Written lab reports
- [x] Practical exercises

Recommended reading:
Operation manuals and laboratory instructions provided online (lecturer's homepage www.home.hs-karlsruhe.de/~wokl0001)

1.3.6 Signals and Systems

Course title: Signals and Systems
Course code: E3B340
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 4 CP
Semester: 3. semester
Name of the lecturer: Prof. Dr. Manfred Strohmann

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 system

Prerequisites:
- 

Course objectives expressed in learning outcomes and competences:

After having successfully completed the course, the students should:
- be able to describe systems with differential equations
- have improved 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
1.3.7 Electrical Machines 1

Course title: Electrical Machines 1
Course code: E3B350
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 6 CP
Semester: 3. semester
Name of the lecturer: Prof. Dr. Thomas Köller

Course contents: recapitulation: law of induction, Ampère's circuital law; single-phase transformer; three-phase transformer; transformer: inrush and sudden short circuit; DC machine: design and operating behavior

Prerequisites: basics in math, electrical engineering

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

- know the functionality and operating behavior of transformers
- know standard problems like inrush and sudden short circuit
- know the principle of electromechanic energy conversion
- know the functionality and operating behavior of DC machines
- be able to solve practical exercises concerning transformers and DC machines

Language of instruction: German

Teaching methods: lecture supported by transparencies
Assessment methods: ✗ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work
☐ Oral exam ☐ Practical exercises ☐

Recommended reading: R. Fischer: Elektrische Maschinen, Hanser Verlag
H. Eckhardt: Grundzüge der elektrischen Maschinen, Teubner Studienbücher
1.4 Fourth Semester

1.4.1 Electromagnetic Field Theory

Course title: Electromagnetic Field Theory
Course code: E4B411
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 4 CP
Semester: 4. semester
Name of the lecturer: Prof. Dr. Günter Langhammer

Course contents:
- Introduction
- Electromagnetic, quasistatic, static electric and magnetic fields
- Mathematical fundamentals
- Properties of vector fields
- The system of Maxwell’s Equations and general theorems
- Wave propagation
- Calculation of electrostatic fields

Prerequisites:
Basic knowledges of electrical engineering (electrical and magnetic fields)
E1B121, E1B122, E2B221

Course objectives expressed in learning outcomes and competences:
- be able to understand the meaning of Maxwell’s Equations
- be able to calculate grad-, div- and rot-operations
- have a basic understanding of conservative and nonconservative fields
- know the principals of electromagnetic wave propagation

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

Recommended reading:

1.4.2 Theory of Digital Systems

Course title: Theory of Digital Systems
Course code: E4B412
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 2 CP
Semester: 4. semester
Name of the lecturer: Prof. Dr. Manfred Stohrmann
Module

1.4.3 Modelling and Simulation

Course title: Modeling and Simulation
Course code: E4B413
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 2 CP
Semester: 4. semester
Name of the lecturer: Prof. Dr. Thomas Köller
Course contents: utilization of modelling and simulation in practice; learning matlab/simulink by means of special exercises (pendular, predator-prey, overhead line ...); numerical inaccuracies; parameter identification
Prerequisites: math, basics in electrical engineering
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should: be able to use matlab/simulink for common problems know about problems concerning numerical stability know the practical usability of parameter identification
Language of instruction: German
Teaching methods: lecture, practical work with matlab/simulink
Module

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

Recommended reading:
Beucher, Ottmar: Matlab und Simulink, Verlag Pearson Studium

1.4.4 Generation, transmission and distribution of electric power

Course title: Generation, transmission and distribution of electric power
Course code: E4B421
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 4 CP
Semester: 4. semester
Name of the lecturer: Prof. Dr. Günter Langhammer

Course contents:
- Terminology and basics in cost calculation, electric power consumption,
- load diagrams, dispatch of power plants, primary energy resources
- power plants (thermal, water, power and voltage control, wind, solar)
- mathematical fundamentals power systems calculation (1,2,0 sequence - components)
- Overhead lines and cables (construction, impedances, equivalent circuits steady state system calculation)
- Grid structures
- Basics of power systems calculation
- Terminology in short circuit calculation
- circuit breakers, disconnectors, switches, fuses

Prerequisites:
Basic knowledges of AC and DC circuit calculation and the fundamentals in electrical engineering

Course objectives expressed in learning outcomes and competences:
- be able to understand and calculate cost structures
- be able to understand and use a correct terminology in power engineering
- be able to understand and explain the thermal circuits of power plants
- be able to understand and use mathematical fundamentals power systems calculation
- know the components, construction, impedances and equivalent circuits of overhead lines and cables
- be able to calculate steady state load flows of basic grid structures
- know basic grid structures
- to understand and use the correct terminology in short circuit calculation
- know the properties of circuit breakers, disconnectors, switches, fuses

Language of instruction: German
Teaching methods: Lecture supported by transperencies and exercises
1.4.5 High Voltage Engineering

Course title: High Voltage Engineering
Course code: E4B422
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 2 CP
Semester: 4. semester
Name of the lecturer: Prof. Dr. Günter Langhammer

Course contents:
- Overvoltages in transmission and distribution systems
- Voltage stress in electric components
- analytic and numeric calculation of electrostatic fields
- electric fields in multi layer dielectrics
- dielectrics under dielectric stress (air, SF6, liquid and solid
- dielectric materials, partial discharges, polarisation effects,
- dielectric breakthrough mechanisms)
- Basics of high voltage test techniques
- Travelling waves

Prerequisites:
Basic knowledges of transmission and distribution systems, physics and electrical apparatus

Course objectives expressed in learning outcomes and competences:
- be able to evaluate operating conditions of high voltage components
- be able to understand the calculation principles of electric field calculation
- be able to evaluate dielectric stress in multi layer dielectrics
- know the basic properties and mechanisms of dielectric materials (air, SF6, liquid and solid dielectric materials, partial discharges, polarisation effects, dielectric breakthrough mechanisms)
- understand the basics high voltage test techniques
- understand wave propagation on lines

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

Recommended reading:
M. Beyer; W. Boeck; K. Möller; W. Zaengl; Hochspannungstechnik, Springer-Verlag Berlin Heidelberg 1986
1.4.6 Electrical Machines 2

Course title: Electrical Machines 2
Course code: E4B430
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 4 CP
Semester: 4. semester
Name of the lecturer: Prof. Dr. Thomas Köller
Course contents: generation of rotating fields; windings; generation of torque; space vector theory; design and operating behaviour of induction machines: equivalent circuit, phase diagram, relationship speed to torque, speed control, single-phase operation; design and operating behaviour of synchronous machines: equivalent circuit, phase diagram, boundary load

Prerequisites: Basics of computer science and electrical engineering

Course objectives expressed in learning outcomes and competences:
- know the functionality and operating behaviour of induction and synchronous machines
- know basics about the space vector theory
- be able to solve practical exercises concerning induction and synchronous machines under steady state conditions

Language of instruction: German
Teaching methods: lecture supported by transparencies
Assessment methods: ✔ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work
☐ Oral exam ☐ Practical exercises ☐

Recommended reading:
- R. Fischer: Elektrische Maschinen, Hanser Verlag
- H. Eckhardt: Grundzüge der elektrischen Maschinen, Teubner Studienbücher

1.4.7 Control Engineering

Course title: Control Engineering
Course code: E4B441
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 4 CP
Semester: 4. semester  
Name of the lecturer: Prof. Dr. Jürgen Gentner  
Course contents: Going beyond the lecture on ‘basics of Computer Science’, this course enters deeper into such topics as codes and number notation of control engineering, boolean algebra, normalization and minimization of boolean equations; timer, counter and state graphs. Structure and components of an automation system, programming languages of sequential control according to IEC 61131 (ladder diagram, function block diagram, sequential function chart) and the statement list of the programmable logic control SIMATIC S7 including the use of operating system function calls.

Students can also perform exercises arising from the applications, either directly in the lab for control engineering or (to a more limited extent) at home using programmable controllers simulation software.

Prerequisites: Basics of computer science and electrical engineering

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

- know structure and components of an automation system,
- know programming languages of sequential control according to IEC 61131 (ladder diagram, function block diagram, sequential function chart) and the statement list of the programmable logic control SIMATIC S7

Language of instruction: German

Teaching methods: Lecture supported by Power Point Slides and Simulation Software

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


1.4.8 Control Engineering

Course title: Control Engineering  
Course code: E4B442  
Type of course: Laboratory  
Level of course: Bachelor  
Degree Program: Energy and Automation Technology  
Year of study: Second year  
ECTS Credits: 2 CP  
Semester: 4. semester  
Name of the lecturer: Prof. Dr. Jürgen Gentner  
Course contents: Six work stations for two students each are at the disposal in the automation lab throughout the duration of the course. Each work station consists of a Personal Computer for program design and an automation system, which controls a model of a production line. Students can control by program pneumatic elements such as daw arms as well as electromechanical elements (motor-driven assembly line, light barriers, proximity sensors and so on) in the process. Moreover, field bus communication components (profibus, ASI bus) can be used in addition to
the parallel peripheral bus. The lab takes place in parallel to the lecture (with a three-week lag), such that theoretic concepts acquired during the lecture can be put into practice immediately. Students can perform exercises arising from the applications, either directly in the lab for control engineering or (to a more limited extent) at home using programmable controllers simulation software. The individual experiments allow students to translate particular problems into appropriate program structures, implement those and prove their workability through integration testing using systematic error tracking. Following documentation of their work, students receive credits for each experiment.

Prerequisites: Basics of computer science and electrical engineering

Course objectives expressed in learning outcomes and competences:

After having successfully completed the course, the students should:

- Solve automation problems and put there solutions into practice using industrial Components.
- be able to design and program a PLC-system

Language of instruction: German

Teaching methods: Laboratory work

Assessment methods:

- [ ] Written exam
- [x] Presentation
- [ ] Written assignment
- [ ] Project work
- [ ] Oral exam
- [x] Practical exercises


1.4.9 Control Theory

Course title: Control Theory

Course code: E4B451

Type of course: Lecture

Level of course: Bachelor

Degree Program: Energy and Automation Technology

Year of study: Second year

ECTS Credits: 4 CP

Semester: 4. semester

Name of the lecturer: Prof. Dr. H. R. Fehrenbach

Course contents: Objectives of this course:

- Linear time invariant systems, modelling, stability and feedback control

Subjects of this course:

- Modelling of signals in time and frequency domain
- Mathematical description of linear systems by ordinary differentials, state space modelling and transfer function
- System analysis by bode and nyquist diagrams
- System structure and parameter Identification of real processes, Algebraic and graphical stability criteria (Hurwitz, Nyquist)
- Transient behaviour and steady state.
- Classical control methods: Dynamic compensation, empirical methods, lead lag compensator, modulus optimum method, symmetrical optimum, root locus techniques
• Analog und digital design of PID controllers

Prerequisites:
System Theory

Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:
• understand, that synthesis of feedback control systems is one of the main topics for an electrical engineer
• describe real processes by mathematical methods, pick out an appropriate controller, synthesize the controller so that given specifications can be satisfied
• be able to solve simple control problems
• be aware of computational tools

Language of instruction: German

Teaching methods:
Lecture supported by Presentation slides completed by blackboard supplements

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

Recommended reading:
Föllinger O.: Regelungstechnik, Einführung in die Methoden und ihre Anwendung, Hüthig Heidelberg, 1994

1.4.10 Control Lab

Course title: Control Lab
Course code: E4B452
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Second year
ECTS Credits: 2 CP
Semester: 4. semester
Name of the lecturer: Prof. Dr. H. R. Fehrenbach

Course contents:
• Objectives of this course:
  • Linear time invariant systems, modelling, stability and feedback control

Subjects of this course:
• Modelling of signals in time and frequency domain
• Mathematical description of linear systems by ordinary differentials, state space modelling and transfer function
• System analysis by bode and nyquist diagrams
• System structure and parameter identification of real processes, Algebraic and graphical stability criteria (Hurwitz, Nyquist)
• Transient behaviour and steady state.
• Classical control methods: Dynamic compensation, empirical methods, lead lag compensator, modulus optimum method,
symmetrical optimum, root locus techniques
• Analog und digital design of PID controllers

Prerequisites: System Theory, Control Theory

Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:
• Identify real processes
• Be able to tune and optimize PID controllers

Language of instruction: German

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

Recommended reading:
Föllinger O.: Regelungstechnik, Einführung in die Methoden und ihre Anwendung, Hüthig Heidelberg, 1994
1.5 Sixth Semester

1.5.1 Power Electronics

Course title: Power Electronics
Course code: E6B611
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 6 CP
Semester: 6. semester
Name of the lecturer: Prof. Dr. 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 Converter, Step-Up Converter, Buck-Boost Converter, Flyback Converter)
- 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 Electrical Engineering 1, Basic Electrical Engineering 2, Electronics

Course objectives expressed in learning outcomes and competences:
- have profound knowledge about power electronic switches, their drive and protection
- possess key skills in of generic power electronic circuits
- be able to analyze and calculate fundamental switched-power supplies
- understand Line-Frequency Phase Controlled Rectifiers and Inverters
- be endowed with practical converter design considerations
- be able to implement the basic control strategies in power electronic systems

Language of instruction: German

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

Recommended reading:
- Anke, Dieter: Leistungselektronik, Oldenbourg, Berlin, 2000
1.5.2 Power Electronics Laboratory

Course title: Power Electronics Laboratory
Course code: E6B612
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 2 CP
Semester: 6. semester
Name of the lecturer: Prof. Dr. Alfons Klönne

Course contents:
This laboratory introduces the student to measurement of important operating characteristics of power electronic circuits and power semiconductor devices. Emphasis is on devices, circuits and control methods.

The different experiments are:
- Step-Down Converter in continuous mode and discontinuous mode
- Step-Up Converter in CCM and DCM,
- Fly back Converter
- 3-Phase Phase-Controlled Half-Bridge Thyristor Rectifier under varying load condition including line currents and harmonics
- 3-Phase Phase-Controlled Full Bridge Thyristor Rectifier and Inverter

Prerequisites:
Basic Electrical Engineering 1, Basic Electrical Engineering 2, Electronics, Introduction to power electronics

Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students be able to:
- be skilled in power electronic measurement methods
- understand the close relationship between hardware and theoretical models of power electronic systems
- know the practical aspects such as control of converters, impact of parasitics, load and supply side interactions
- be accustomed with Fourier analysis and power quality aspects

Language of instruction: German

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

Recommended reading:

1.5.3 Thermodynamics

Course title: Thermodynamics
Course code: E6B621
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 4 CP
Semester: 6. semester
Name of the lecturer: Prof. Dr. Karl Ehinger
Course contents:
- Temperature- and pressure sensors
- Thermal properties of gases, fluids and solids
- Energy, enthalpy, entropy, anergy, exergy
- Laws of thermodynamics
- States of aggregation and phase transitions
- Heat engine cycle. Carnot cycle, Otto cycle, Diesel cycle, Stirling cycle
- Steam plant, Rankine cycle
- Gas turbines, Joule cycle, Ericson cycle
- Reverse cycle heating system, heat pump, refrigerating machine

Prerequisites: Basics in Physics and Mathematics
Course objectives expressed in learning outcomes and competences:
- be able to assess, evaluate and improve thermodynamic processes.

Language of instruction: German
Teaching methods: transparencies (classical and powerpoint presentation), experiments, scientific movies, exercises
Assessment methods:
- Written exam
- Presentation
- Written assignment
- Project work
- Oral exam
- Practical exercises

Recommended reading:
- K. Ehinger: Script
- G. Cerbe, Technische Thermodynamik, Hanser Verlag
- K. Langeheinecke, Thermodynamik für Ingenieure, Vieweg Verlag

1.5.4 Electrical Machines Laboratory

Course title: Electrical Machines Laboratory
Course code: E6B622
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 2 CP
Semester: 6. semester
Name of the lecturer: Dipl.-Ing. (FH) Sekinger
Course contents: measurements concerning the operating behaviour of transformers, DC machines, induction machines and synchronous machines

Prerequisites: basics in electromechanic energy conversion (see lectures Electrical Machines 1 and 2)
Course objectives expressed in learning
After having successfully completed the course, the students be able to:
Module

outcomes and competences:
- be able to apply transformers and machines in practice
- be able to measure characteristic quantities concerning electrical machines

Language of instruction: German

Teaching methods: laboratory, experiments

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

Assessment methods:
- Presentation
- Project work

Recommended reading:
- R. Fischer: Elektrische Maschinen, Hanser Verlag
- H. Eckhardt: Grundzüge der elektrischen Maschinen, Teubner Studienbücher

1.5.5 Electromagnetic Compatibility (EMC)

Course title: Electromagnetic Compatibility (EMC)
Course code: E6B631
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 4 CP
Semester: 6. semester
Name of the lecturer: Prof. Dr. 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
- Treatment of EMC-problems
- overvoltage protection

Prerequisites:
Good knowledge of basic physics and the fundamentals in electrical engineering

Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students be able to:
- 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: German
1.5.6 Electromagnetic Compatibility Lab

Course title: Electromagnetic Compatibility Lab
Course code: E6B632
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 2 CP
Semester: 6. semester
Name of the lecturer: Prof. Dr. Günter Langhammer
Course contents:
- experiments to show the basics of electric and magnetic coupling
- experiments to show the electric and magnetic field influence on electric
- devices and shielding mechanisms
- radiated electromagnetic interference tests with GTEM cells
- electromagnetic susceptibility tests with GTEM cells
- test against electrostatic discharges

Prerequisites: Knowledge of contents of EMC lecture
Course objectives expressed in learning outcomes and competences:
- be able to understand the basics of electric and magnetic couplings
- be able to understand the influence of electric and magnetic fields on electric devices and the application of shielding
- be able to understand the basics if radiated electromagnetic interference
- measurements with GTEM cells
- be able to understand the basics of electromagnetic susceptibility tests with GTEM cells
- be able to understand test procedures for electrostatic discharges

Language of instruction: German
Teaching methods: Experiments
Assessment methods:
- Written exam
- Presentation
- Written assignment
- Project work
- Oral exam
- Practical exercises
1.5.7 High Voltage Lab

Course title: High Voltage Lab
Course code: E6B633
Type of course: Laboratory
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 2 CP
Semester: 6. semester
Name of the lecturer: Prof. Dr. Günter Langhammer
Course contents:
- Generation and measurement of high AC-voltages
- Generation and measurement of high DC-voltages
- Generation and measurement of high impulse-voltages
- Travelling waves

Prerequisites: Knowledge of contents of high voltage engineering
Course objectives expressed in learning outcomes and competences:
- be able to understand the generation and measurement techniques of high AC-voltages and their safe application
- be able to understand the generation and measurement techniques of high DC-voltages and their safe application
- be able to understand the generation and measurement techniques of high impulse-voltages and their safe application
- understand the behaviour of travelling waves in power systems

Language of instruction: German
Teaching methods: Experiments
Assessment methods: Written exam
Recommended reading:

1.5.8 Automation Engineering

Course title: Automation Engineering
Course code: E6B441
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Third year
ECTS Credits: 6 CP
Semester: 6. semester
Name of the lecturer: Prof. Dr. Jürgen Gentner
Course contents:
- types of processes
- theory of process models (R&I, mathem. model, state diagram)
- process instrumentation, process I/O
- scaling and supervision of variables
- field bus systems
- operator control and monitoring

**Prerequisites:** Knowledge of programmable logical control systems and control engineering

**Course objectives expressed in learning outcomes and competences:**
- know structure and components of an process automation system,
- be able to identify the relevant automation technology issues, hard and software solutions as well as systems.

**Language of instruction:** German

**Teaching methods:** Lecture supported by Power Point Slides

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

**Recommended reading:**

### 1.5.9 Automation Engineering

**Course title:** Automation Engineering
**Course code:** E6B442
**Type of course:** Laboratory
**Level of course:** Bachelor
**Degree Program:** Energy and Automation Technology
**Year of study:** Third year
**ECTS Credits:** 2 CP
**Semester:** 6. semester
**Name of the lecturer:** Prof. Dr. Jürgen Gentner

**Course contents:** After introduction by the lecturer the students work on practical projects, resolving all the practical problems of process automation.

**Prerequisites:** Knowledge of programmable logical control systems and control engineering

**Course objectives expressed in learning outcomes and competences:**
- know structure and components of an process automation system
- be able to program and start up an automation system
- be able to create a human machine interface.

**Language of instruction:** German

**Teaching methods:** Lecture supported by Power Point Slides

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

Course title: Project work  
Course code: E6B650  
Type of course: Project  
Level of course: Bachelor  
Degree Program: Energy and Automation Technology  
Year of study: Third year  
ECTS Credits: 8 CP  
Semester: 6. semester  
Name of the lecturer: all lecturers  
Course contents: Project organization and implementation according to ISO9000, illustrated with concrete examples - to be worked out in small groups  
Prerequisites: Modules of semester 1 up to 4  
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students be able to:  
- establish specification  
- structure a project  
- establish time table  
- make team discussion with minute keeping  
- present results  
Language of instruction: German  
Teaching methods: After brief introduction the students autonomously work on their project. The status of the project is to be discussed with lecturer on a regular basis.  
Assessment methods:  
- Written exam  
- Written assignment  
- Oral exam  
- Practical exercises  
- Presentation  
- Project work  
1.6 Seventh Semester

1.6.1 Power Network Planning and Operation

Course title: Power Network Planning and Operation
Course code: E7B711
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Fourth year
ECTS Credits: 6 CP
Semester: 7. semester
Name of the lecturer: Prof. Dipl.-Ing. Guntram Schultz
Course contents: Co-operation of the different components in a power supply system, Regulation of transformers to control load flow, Planning principles in power systems, Methods of digital power system analysis, Load flow and short circuit programs, basics of reliability theory
Prerequisites: Basic knowledge of power systems
Course objectives expressed in learning outcomes and competences:
- know how power transmission and distribution systems are planned and operated
- be able to use load flow and short circuit programs.
Language of instruction: German
Teaching methods: Lecture, slides, Matlab examples
Assessment methods: ☒ Written exam ☐ Presentation ☐
☐ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐
Recommended reading: O. Oeding, B.R. Oswald: Elektrische Kraftwerke und Netze, Springer Verlag
K. Heuck, K.D. Dettmann: Elektrische Energieversorgung, Vieweg Verlag
R. Flosdorff, G. Hilgarth: Elektrische Energieverteilung, Teubner Verlag
W. Knies, K. Schierack: Elektrische Anlagentechnik, Hanser Verlag

1.6.2 Safety measures in power systems

Course title: Safety measures in power systems
Course code: E7B713
Type of course: Lecture
Level of course: Bachelor
Degree Program: Energy and Automation Technology
Year of study: Fourth year
ECTS Credits: 3 CP
Semester: 7. semester
Name of the lecturer: Prof. Dipl.-Ing. Guntram Schultz
Course contents: Effects of electricity to human beings, legal regulations, safety measures in low- and in high voltage power systems, grounding systems, protection against overvoltages and lightning strokes, protection against overload and short circuit, network protection relays, fire protection, corrosion protection
### Module

**Prerequisites:** Basic knowledge of power systems

**Course objectives expressed in learning outcomes and competences:**
- be able to understand the various mechanisms of protecting against the dangers of electricity.

**Language of instruction:** German

**Teaching methods:** Lecture, slides

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

**Recommended reading:**
- K. Heuck, K.D. Dettmann: Elektrische Energieversorgung, Vieweg Verlag
- W. Knies, K. Schierack: Elektrische Anlagentechnik, Hanser Verlag
- G. Kiefer: VDE 0100 und die Praxis, VDE Verlag
- R. Flosdorff, G. Hilgarth: Elektrische Energieverteilung, Teubner Verlag

### 1.6.3 Business Administration

**Course title:** Business Administration

**Course code:** E7B722

**Type of course:** Lecture

**Level of course:** Bachelor

**Degree Program:** Energy and Automation Technology

**Year of study:** Fourth year

**ECTS Credits:** 3 CP

**Semester:** 7. semester

**Name of the lecturer:** Lecturers Studium Generale

**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

**Prerequisites:** -

**Course objectives expressed in learning outcomes and competences:**
- possess basic management knowledge.

**Language of instruction:** German

**Teaching methods:** Lecture supported by Power Point slides, exercises, group work

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


Script and Documents of the Lecturer