Module Handbook

Master’s Program:

Elektrotechnik
(Electrical Engineering)

Master of Engineering

Stand: 17.03.2009
1 Module

1.1 First Semester

1.1.1 Distributed Control Systems

Course title: Distributed Control Systems
Course code: E1M110
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 8 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr. Urban Brunner

Course contents:

Part I: Advanced digital control
- Repetition of classical control theory, limits in classical control
- Modelling for control, normal forms
- Sampling and reconstruction of signals, discretization of continuous plants, discretization of continuous controllers
- State space feedback with observer (pole placement, LQR, Luenberger observer, Kalman filter)
- Disturbance estimation, state space feedback with integral action
- Deadbeat and cancellation controllers (pros and cons)
- Hierarchical and decentralized control of large scale systems

Part II: Process automation
- Architecture and operation of process automation systems
- PLC-programming according to IEC 1131-3
- Validation and verification of safety related programming
- Modelling and analysis of event driven systems (Petri Nets, FSM)
- Supervisory control (controller synthesis by Ramadge-Wonham)
- Modelling and simulation of hybrid systems (Simulink/Stateflow)

Prerequisites: System Theory, Control Theory

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

- know the architecture and operation of process automation systems
- be able to cope with complexity of distributed systems
- understand the limits in classical control and be able to combine classical control concepts with modern control theory
- be able to model event driven systems and to analyze Petri Nets
- understand the concepts of reachability, liveness, and Petri Net invariants
- be able to model and analyze hybrid systems that exhibits both continuous and discrete dynamic behaviour

Language of instruction: German
Teaching methods: Lecture supported by transparencies and Power Point slides, MATLAB simulations, and demonstrations in the control laboratory
Assessment methods:
- [x] Written exam
- [ ] Presentation
- [ ] Written assignment
- [ ] Project work
- [ ] Oral exam
- [ ] Practical exercises

Recommended reading:

1.1.2 Process Visualization

Course title: Process Visualization
Course code: E1M121
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 3 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr.-Ing. Jürgen Gentner

Course contents:
- principles of human cognition
- requirements and technology of dialog systems
- usability: guidelines and standard specification

Prerequisites:
Knowledge of programmable logical control systems and control engineering

Course objectives expressed in learning outcomes and competences:
- know how to map technical processes into a plant visualization
- be able to realize a human machine interface with regard to usability requirements

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

Recommended reading:
1.1.3 Fieldbus systems

Course title: Fieldbus systems
Course code: E1M122
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 2 + 1 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr. M. Katz

Course contents:
• short review of industrial fieldbuses
• concept of virtual fieldbus devices and their applications
• device description languages and some techniques of formal description
• software interface technologies (XML, GSDL, EDDL, COM/DCOM, .NET)
• application examples: diagnosis, maintenance, engineering
• by way of example some concrete fieldbus integration models are discussed: GSD, OPC-UA, CBA of PROFIBUS/PROFInet, EDD for FF/PROFINet, DD for HART, FDT/DTM as an fieldbus independent integration technology

Prerequisites: Basic technical skills in industrial communication technology, field buses and deeper knowledge of information technology

Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:
• know the fundamental architecture of a industrial application integration in a fieldbus system
• know fundamental concepts of GSD, OPC UA, CBA, DD, EDD(L), FDT/DTM
• have an idea of how to put this knowledge into real tasks of automation and process technology

Language of instruction: German
Teaching methods: blackboard notes, beamer presentation of subject matter and examples of implementation

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
Reißenweber, B.: Feldbussysteme, Oldenbourg 1998
Riedl, M., Simon, R., EDDL Electronic Device Description Language, Oldenbourg Verlag 2002
Industrial Communication Technology Handbook, CRC Press, Richard
## 1.1.4 Optical Communication

<table>
<thead>
<tr>
<th>Course title:</th>
<th>Optical Communication</th>
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<tbody>
<tr>
<td>Course code:</td>
<td>E1M130</td>
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<tr>
<td>Type of course:</td>
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<td>Degree Program:</td>
<td>Electrical Engineering</td>
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<tr>
<td>Year of study:</td>
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<td>ECTS Credits:</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. Grünhaupt</td>
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<tr>
<td>Course contents:</td>
<td>Optical Fiber Basics, Fiber Optic Measurement Techniques, Optical Emitters, Optical Detectors, Optical Amplifiers, Fiber Optic Communication Systems</td>
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<tr>
<td>In the Lab:</td>
<td>Use of the OTDR, Splicing of Fibers, Measurement of Bit error rate and Dispersion, Characterization of an Erbium Doped Fiber Amplifier</td>
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</tbody>
</table>

### Prerequisites:
- Optics basics, solid state physics, radio frequency engineering

### Course objectives expressed in learning outcomes and competences:
- know the basics and components of fiber optical communication systems
- be able to develop and design optical communication systems and use appropriate measuring methods to characterize them

### Language of instruction:
- German

### Teaching methods:
- lecture with slides, blackboard presentation, videos, examples in lab.

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

### Recommended reading:
1.1.5 Switching Power Supplies

Course title: Switching Power Supplies
Course code: EL1M140
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 6 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr. Alfons Klönne

Course contents:
- Role of Power Supply within the System
- Fundamentals of Pulsewidth Modulated Switching Power Supplies
- Basic Switching Circuits in CCM and DCM (Charge Pumps, Buck Converter, Boost Converter, Inverting Boost Converter, Buck-Boost Converter, Transformer Isolated Converters)
- Transformer-Isolated Circuits in CCM and DCM (Feedback Mechanism, Fly back Circuit, Forward Converter, Push-Pull Circuits, Half Bridge Circuits, Full Bridge Circuits)
- Quasi Resonant Converters
- Magnetic Components
- Power Stage Transfer Function
- Compensation in Switching Regulator Design

Prerequisites: Electronics, Control Engineering

Course objectives expressed in learning outcomes and competences:
- understand the functionality and the components of switching power supplies
- has an overview of non-isolated and isolated power supplies
- be able to design and calculate switching power supplies in DCM and CCM
- efficiently design power inductors and high-frequency magnetics for switching power supplies

Language of instruction: German

Teaching methods: Lecture and exercises
Assessment methods: 
- Written exam
- Written assignment
- Oral exam

Recommended reading:
- Schlienz, Ulrich: Schaltnetzteile und ihre Peripherie, Vieweg Verlag
- Brown, Power Supply Cookbook, Verlag Newnes
- Maniktala, Switching Power Supplies, Verlag Newnes

1.1.6 Electromagnetic Compatibility Testing

Course title: Electromagnetic Compatibility Testing
Course code: E1M151
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Module 7

Year of study: First year
ECTS Credits: 2 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr.-Ing. Günter Langhammer

Course contents:
- Overview about standard EMC tests
- Measurement of interference
- EMI-tests and related equipment (EMC receiver, spectrum analyser,
  GTEM cells, antennas, etc.)
- EMS-tests and related equipment (burst, surge, ESD, radiated electromagnetic fields etc.)

Prerequisites: Good knowledge of contents of EMC lecture

Course objectives expressed in learning outcomes and competences:
- know and understand the basics of EMI- and EMS-test equipment
- know a selection of basic EMI-test procedures
- know a selection of basic EMS-test procedures

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

Recommended reading:

1.1.7 Electrochemical energy storage systems and converters

Course title: Electrochemical energy storage systems and converters
Course code: E1M152
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 4 CP
Semester: 1. semester
Name of the lecturer: Dr. Tübke
Course contents: Basics of electrochemistry and various energy storage and converting technologies, electrochemical potential

Construction and function principle of fuel cells (PEMFC, DMFC, SOFC, MCFC), fuels for fuel cells, reforming of fuels,

Construction and function principles of various primary and secondary batteries (Volta battery, Leclanche cell, alkaline battery, zinc-carbon battery, lead-acid battery, zinc-air battery, nickel-cadmium battery, nickel metal hydride battery, high temperature batteries, lithium ion battery, redox flow battery, battery management, battery charger and charging methods, Construction and function principles of double layer capacitors,
Hybride systems (combination of fuel cells, battery and double layer capacitors)

Prerequisites: -

Course objectives expressed in learning outcomes and competences:

After having successfully completed the course, the students should:

- have basic knowledge in different energy storage systems as well as energy converters
- be able to design an energy storage device for a chosen application within certain general conditions (capacity, power, charge method, infrastructure, costs)

Language of instruction: German

Teaching methods: Oral presentation

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

Recommended reading:
- Batterien, Heinz-Albert Kiehne, Expert Verlag, 2000
- Batterietechnik, Heinz Wenzl, Expert Verlag, 1999
- Batterie-Lexikon, Hans-Dieter Jaksch, Pflaum-Verlag, München, 1993
- Brennstoffzellentechnik, Peter Kurzweil, Vieweg Verlag, 2003

1.1.8 Information theory and coding

Course title: Information theory and coding
Course code: E1M161
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 4 CP
Semester: 1. semester
Name of the lecturer: Prof. Dr. Franz Quint

Course contents:
Basic concepts of information theory are introduced, based on Shannon's theorems on source and channel coding. Source coding is introduced with the Huffman code and arithmetic coding. Bandwidth efficiency plane and the Shannon limit are discussed. In the part channel coding a general treatment of block codes is given, followed by the Galois-field theory, Reed-Solomon and BCH coding and decoding with algebraic methods. Convolutional codes are discussed and the Viterbi-algorithm is presented. The course concludes with interleaving, generalized code concatenation and coded modulation

Prerequisites: System theory, probability.

Course objectives expressed in learning outcomes and competences:

After having successfully completed the course, the students should:

- be able to design block and convolutional codes
- be able to implement decoding algorithms
be able to assess the impact of coding to data transmission

<table>
<thead>
<tr>
<th>Language of instruction:</th>
<th>English</th>
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<tbody>
<tr>
<td>Teaching methods:</td>
<td>Lecture, PowerPoint slides,</td>
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<tr>
<td>Assessment methods:</td>
<td>☑️ Written exam ☐ Presentation</td>
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<td></td>
<td>☐ Written assignment ☐ Project work</td>
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<tr>
<td></td>
<td>☐ Oral exam ☐ Practical exercises</td>
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<tr>
<td>Recommended reading:</td>
<td>M. Bossert: Kanalcodierung Teubner, Stuttgart, 1998</td>
</tr>
<tr>
<td></td>
<td>R. Blahut: Theory and Practice of Error Control Codes, Addison Wesley, 1983</td>
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1.1.9 Test of digital systems

<table>
<thead>
<tr>
<th>Course title:</th>
<th>Test of digital systems</th>
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<tr>
<td>Course code:</td>
<td>E1M162</td>
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<tr>
<td>Type of course:</td>
<td>Lecture</td>
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<tr>
<td>Level of course:</td>
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<td>Degree Program:</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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<td>Semester:</td>
<td>1. semester</td>
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<tr>
<td>Name of the lecturer:</td>
<td>Prof. Dr.-Ing. Gerhard Schäfer</td>
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<tr>
<td>Course contents:</td>
<td>The test of digital system as an integral part of a design process is presented. Fault models (e.g. Stuck at faults, D-Notation) are introduced and related to certain test pattern generation procedures. Fault simulation techniques and the calculations of test coverage figures are shown on different test cases. Standard tests procedures (e.g. RAM, ROM - Test) will be presented as well as the use of build in self test methods (BIST). Scan path techniques inside a chip and board test procedures like boundary scan are described, too. Practical rules concerning the Design for testability (DFT) are given as guidelines.</td>
</tr>
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</table>

Prerequisites: Good understanding of high voltage basics

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

- know the effects of fault models
- be able to verify the testability of a digital circuits (DFT)
- know the application of test pattern generation procedure
- know the use and application of boundary scan techniques
- be able to apply standard test techniques (e.g. BIST, ROM- or RAM tests)
### Assessment methods:
- [x] Written exam
- [ ] Presentation
- [ ] Written assignment
- [ ] Project work
- [ ] Oral exam
- [ ] Practical exercises

### Recommended reading:
1.2 Second Semester

1.2.1 RF Instrumentation

Course title: RF Instrumentation
Course code: E2M171
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 6 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Hans A. Sapotta
Course contents:
- the oscilloscope in the field of RF
- the spectrum-analyzer from inside
- rf sources with emphasis on phase noise
- the network-analyzer from inside
- noise figure measurements
- laboratory on rf instrumentation:
  - rf mixer
  - FM-receiver
  - network analyzer
  - CAD in the field of rf
  - LC-oscillator
Prerequisites: System theory, digital signal processing
Course objectives expressed in learning outcomes and competences:
- be able to use spectrum analyzers at their limits
- be able to use network analyzers at their limits
- be able to make any kind of rf measurements
Language of instruction: German
Teaching methods: lecture, laboratory
Assessment methods:
- [X] Written exam
- [ ] Presentation
- [ ] Written assignment
- [ ] Project work
- [ ] Oral exam
- [ ] Practical exercises

Recommended reading:
Several Application Notes from Tektronix, Agilent and Rohde&Schwarz

1.2.2 RF Systems

Course title: RF Systems
Course code: E2M172
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering  
Year of study: First year  
ECTS Credits: 2 CP  
Semester: 2. semester  
Name of the lecturer: Prof. Dr. Hans A. Sapotta  
Course contents:  
- receiver architecture  
- straight through receivers  
- super regenerative receivers  
- any kind of superhet-receivers  
- mixer stages  
- oscillators with emphasis on integrated oscillators  
- rf propagation in real landscape  
- ionospheric reflection and natural noise sources  
- multipath fading  
- AM and FM Modulation with emphasis on multipath effects  
- Digital Audio Broadcasting  
Prerequisites: Bachelor Degree, course in RF technique  
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:  
- have an overview on different kinds on receivers  
- have an overview on propagation effects  
- have an overview on different kinds of analog and digital modulation techniques  
Language of instruction: German  
Teaching methods: lecture using blackboard, beamer and powderpoint, transparencies  
Assessment methods: ☒ Written exam ☐ Presentation  
 ☐ Written assignment ☐ Project work  
 ☐ Oral exam ☐ Practical exercises  

1.2.3 Signal and parameter estimation

Course title: Signal and parameter estimation  
Course code: E2M181  
Type of course: Lecture  
Level of course: Master  
Degree Program: Electrical Engineering  
Year of study: First year  
ECTS Credits: 2 CP  
Semester: 2. semester  
Name of the lecturer: Prof. Dr. Joachim Stöckle, Prof. Dr. Franz Quint  
Course contents: The course gives the basic concepts of parameter estimation and spectral analysis. The fundamental concepts of estimators are discussed and
emphasis is given on linear methods for parameter estimation. Both classical and parametric methods of spectral estimation are introduced: Yule-Walker equation, Levinson-Durbin recursion and spectral estimators relying on it (e.g. Burg) are discussed.

Prerequisites: System theory, digital signal processing
Course objectives After having successfully completed the course, the students should:

- be able to understand the theory of parameter estimation
- be able to implement a linear parameter estimator
- know the principles of spectral estimation
- be able to decide, under which circumstances to use classical or parametric spectral estimations and to assess the implications of it

Language of instruction: English
Teaching methods: Lecture, PowerPoint slides
Assessment methods: [ ] Written exam [ ] Presentation [ ]
[ ] Written assignment [ ] Project work [ ] Oral exam [ ] Practical exercises [ ]

1.2.4 Analog Digital Systems

Course title: Analog Digital Systems
Course code: E2M182
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 4 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr.-Ing. Rudolf Koblitz
Course contents: The lecture gives a detailed insight into the theory and practice of phase-looked Loop Systems (PLL). In particular, the fundamental loop-aspects are handled: different phase-Comparators, loop-filter and VCO. The acquisition-behaviour is studied in detail applying the Phase-Plane-approach. The nonlinear behaviour and special effects as hang-up and cycle-slip will be discussed.

Prerequisites: Knowledge in Control engineering, System-Theorie (Laplace-Transformation), basic knowledge in Electronics
Course objectives After having successfully completed the course, the students should:

- be able to design a PLL by given VCO and Phase-Comparator parameters
• Judge and compare different Phase-Comparators
• to simulate a PLL with PSPICE and represent the Simulation-
  results in the Phase-Plane
• interpret the results and trajectories of the Phase-Plane

Language of
instruction: German or English, dependent on the members of the audience

Teaching methods: Lecture, slides, Tutorial in german or english, PSPICE Simulation

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

Recommended
reading:
Web-pages:
http://www.uoguelph.ca/~antoon/gadgets/pll/pll.html
http://www.complextoreal.com/tutorial.htm
  • Tutorial 18: Unlocking the Phase Locked Loop (PLL) – Part 1
  • Tutorial 19: Unlocking the Phase Locked Loop (PLL) – Part 2.

1.2.5 Signal Processing in Communication Systems

Course title: Signal Processing in Communication Systems
Course code: E2M161
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 2 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Manfred Litzenburger
Course contents:
• Adaptive filters and equalisation
• Maximum likelihood detection
• Channel estimation / system identification
• Multi-antenna algorithms (smart antennas, beamforming, MIMO)

Prerequisites: Knowledge in Systems Theory, Digital Signalprocessing, and Communication Technology

Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:
• understand principles and performance of advanced signal processing algorithms in modern digital communication systems like adaptive equalisation, optimum sequence detection, and multi-
  antenna processing
• know the principles of adaptive optimisation for signal transmission
• be able to apply these principles to adaptive systems like equalisers and smart antennas
1.2.6 Architectures of Communication Systems

Course title: Architectures of Communication Systems
Course code: E2M162
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 2 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr. Manfred Litzenburger

Course contents:
- Transmitter- and receiver architectures, digital frontends
- Digital down- and upconversion
- Multirate signal processing
- Direct digital synthesis (DDS)
- A/D- und D/A-converters in communication systems
- Software Defined Radio

Prerequisites: Knowledge in Systems Theory, Digital Signal processing, and Communication Technology

Course objectives expressed in learning outcomes and competences:
- understand the architectural principles and components of modern digital communication systems
- be able to design critical building blocks in the digital frontend of a communication device, like filters, decimators, and converters
- know the motivation and the background of software-defined radios and the roads to their realisation

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

Recommended reading:
1.2.7 Electrical Drives

Course title: Electrical Drives
Course code: E2M130
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 8 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr.-Ing. Thomas Köller

Course contents:
- planning of electrical drives:
  - path planning, gears, overload of machines
- control of electrical drives:
  - dimensioning of controllers (current control, speed control),
  - control structures e.g. cascade control,
  - dynamic behaviour of DC machines,
  - dynamic behaviour of polyphase machines,
  - dynamic control of polyphase machines,
  - vector control, space vector modulation,
  - nonlinear position control,
  - measuring tools concerning drive control (position and speed)
  - control of elastic systems

Prerequisites: basics in electromechanic energy conversion (steady state behavior of DC machines and AC machines), basics in space vector theory

Course objectives expressed in learning outcomes and competences:
- After having successfully completed the course, the students should:
  - be able to parameterize controllers of electrical drives
  - know the common control structures in drive systems
  - be able to design the vector control of AC machines
  - know how to simulate dynamic behaviour of electrical drives

Language of instruction: German
Teaching methods: lecture supported by transparencies, practical work (simulation with matlab/simulink), laboratory course
Assessment methods: ☑ Written exam ☐ Presentation ☐
☑ Written assignment ☐ Project work ☐
☐ Oral exam ☐ Practical exercises ☐
Recommended reading: Schröder, Dierk: 'Elektrische Antriebe - Grundlagen', Springer Verlag

1.2.8 High Voltage Measurement and Testing

Course title: High Voltage Measurement and Testing
Course code: E2M141
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 4 CP  
Semester: 2. semester  
Name of the lecturer: Prof. Dr.-Ing. Günter Langhammer  
Course contents:  
• Insulation stress caused by overvoltages in transmission and distribution systems  
• German and international standards  
• generation of high AC, DC an impulse voltages  
• measurement of high AC, DC and impulse voltages  
• diagnostic test procedures (C, tan δ, partial discharges)  
• nonelectric test procedures (thermography, chemical oil tests)

Prerequisites: basics in electromechanic energy conversion (steady state behavior of DC machines and AC machines), basics in space vector theory  
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:  
• be able to evaluate insulation stress caused by overvoltages in transmission and distribution systems  
• know the system of german and international standards  
• know and understand the principles of generation of high AC, DC an impulse voltages  
• know and understand the principles of measurement of high AC, DC and impulse voltages  
• know the diagnostic test procedures for C, tan δ and partial discharges  
• know the most important nonelectric test procedures (thermography, chemical oil tests)

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  

1.2.9 High Voltage Test and Measurement Lab  
Course title: High Voltage Test and Measurement Lab  
Course code: E2M142  
Type of course: Laboratory  
Level of course: Master  
Degree Program: Electrical Engineering  
Year of study: First year  
ECTS Credits: 2 CP  
Semester: 2. semester  
Name of the lecturer: Prof. Dr.-Ing. Günter Langhammer  
Course contents:  
• Dielectric strength of liquid and solid insulation materials  
• Dielectric measurements with liquid and solid insulation materials  
• Measurement of partial discharges  
• Time domain measurement of high impulse voltages
Prerequisites: Good understanding of high voltage basics
Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should:
• know and be able to apply the correct measurement techniques to determine the dielectric strength of liquid and solid insulation materials
• know and be able to apply the correct measurement techniques to determine \( \varepsilon_r \), tan \( \delta \), C, surface resistance, volume resistivity of insulation materials
• know and be able to apply the correct measurement techniques for partial discharges
• know problems and be able to apply the correct techniques of time domain measurement of high impulse voltages

Language of instruction: German
Teaching methods: Experiments
Assessment methods: 
- Written exam
- Written assignment
- Oral exam
- Practical exercises

Recommended reading:
M. Beyer; W. Boeck; K. Möller; W. Zaengl; Hochspannungstechnik; Springer-Verlag Berlin Heidelberg 1986

1.2.10 Energy Efficiency

Course title: Energy Efficiency
Course code: E2M151
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 2 CP
Semester: 2. semester
Name of the lecturer: Prof. Dr.-Ing. Hermann R. Fehrenbach
Course contents: energy situation national and international basics in
• energy management
• thermodynamics

efficient use of energy in
• traffic carriers
• private households
• industry
• producing electrical energy
combined heat and power generation

Prerequisites: Basic knowledge of physics

Course objectives expressed in learning outcomes and competences:
After having successfully completed the course, the students should be able to assess:
• concepts of exergie maximazation

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1.2.11 Renewable Energies

Course title: Renewable Energies
Course code: E2M152
Type of course: Lecture
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 2 CP
Semester: 2. semester
Name of the lecturer: Prof. Dipl.-Ing. Guntram Schultz
Course contents: Conventional versus alternative energies, hydroelectricity, wind energy, solar thermal energy, solar photovoltaics, geothermal energy, bioenergy, hydrogen technology
Prerequisites: Basic knowledges of power systems
Course objectives expressed in learning outcomes and competences: After having successfully completed the course, the students should:

- be able to understand the various renewable energy sources
- be able to understand how photovoltaic -, wind power -, hydro power -, geothermal power -, biomass power -, and fuel cell power plants operate

Language of instruction: German
Teaching methods: Lecture, slides
Assessment methods: Written exam, Presentation, Written assignment, Project work, Oral exam, Practical exercises
Recommended reading:
- K. Heinloth: Die Energiefrage, Vieweg Verlag
- R. A. Zahoransky: Energietechnik, Vieweg Verlag
- J. Fricke, W. L. Borst: Energie, Oldenburg Verlag

1.2.12 Tolerances in networked systems

Course title: Tolerances in networked systems
Course code: E2M110
<table>
<thead>
<tr>
<th>Type of course:</th>
<th>Lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of course:</td>
<td>Master</td>
</tr>
<tr>
<td>Degree Program:</td>
<td>Electrical Engineering</td>
</tr>
<tr>
<td>Year of study:</td>
<td>First year</td>
</tr>
<tr>
<td>ECTS Credits:</td>
<td>4 CP</td>
</tr>
<tr>
<td>Semester:</td>
<td>2. semester</td>
</tr>
<tr>
<td>Name of the lecturer:</td>
<td>Prof. Dr. M. Strohrmann</td>
</tr>
<tr>
<td>Course contents:</td>
<td>• Fundamentals in Statistics</td>
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<tr>
<td></td>
<td>• Statistical description of tolerances</td>
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<td></td>
<td>• Statistical tests</td>
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<td></td>
<td>• Sensitivities in Systems, regression models</td>
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<td></td>
<td>• Tolerance calculation in systems</td>
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<td></td>
<td>• Statistical control of processes</td>
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<td></td>
<td>• Statistical optimization</td>
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<tr>
<td>Prerequisites:</td>
<td>-</td>
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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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<tr>
<td></td>
<td>• be able to describe statistical data</td>
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<td></td>
<td>• have improved the knowledge in statistical distributions</td>
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<td></td>
<td>• be able to apply statistical tests</td>
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<td></td>
<td>• know regression and correlation methods</td>
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<td>• be able to perform tolerance calculations for systems</td>
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<td></td>
<td>• have knowledge in statistic process control</td>
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<td></td>
<td>• be able to perform statistical optimization</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 in combination with computer exercises</td>
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<tr>
<td>Assessment methods:</td>
<td>□ Written exam □ Presentation □</td>
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<tr>
<td></td>
<td>□ Written assignment □ Project work □</td>
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<tr>
<td></td>
<td>□ Oral exam □ Practical exercises □</td>
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<tr>
<td>Recommended reading:</td>
<td>Strohrmann, M, Design For Six Sigma</td>
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<td></td>
<td>Hanser Verlag, München, 2008</td>
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**1.2.13 Medical Sensorics**

<table>
<thead>
<tr>
<th>Course title:</th>
<th>Medical Sensorics</th>
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<tbody>
<tr>
<td>Course code:</td>
<td>E2M191</td>
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<tr>
<td>Type of course:</td>
<td>Lecture</td>
</tr>
<tr>
<td>Level of course:</td>
<td>Master</td>
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<td>Degree Program:</td>
<td>Electrical Engineering</td>
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<tr>
<td>Year of study:</td>
<td>First year</td>
</tr>
<tr>
<td>ECTS Credits:</td>
<td>2 CP</td>
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<tr>
<td>Semester:</td>
<td>1. semester</td>
</tr>
<tr>
<td>Name of the lecturer:</td>
<td>Prof. Dr. Dieter Höpfel</td>
</tr>
<tr>
<td>Course contents:</td>
<td>Electrical effects generated in the body play an important role in medicine. The electricity generated inside the body controls and operates nerves, muscles, and organs. Essentially, all functions and activities of the body involve electricity in some way. In carrying out the special functions of the body, many electrical signals are generated. These signals are the result of the electrochemical action of certain types of cells. During this course we will discuss some of these signals, specifically how</td>
</tr>
</tbody>
</table>
they are generated and measured. After an introduction to the general creation and flow of electrical signals in nerves the electrical potentials of nerve transmission and the electrical signals are explained, seen in the electromyogram (EMG) of muscles, the electrocardiogram (ECG) of the heart, and the electroencephalogram (EEG) of the brain. Furthermore, the course will examine how blood pressure is measured and the measurement of the oxygen content in the blood.

**Prerequisites:** Bachelor Degree

**Course objectives expressed in learning outcomes and competences:**

After having successfully completed the course, the students should:

- be able to understand the creation and propagation of electrical signals in nerves and muscles and their measurement with appropriate sensors. The students should understand the measurement and interpretation of the signals of EMG, ECG, EEG, blood pressure and oxygen content in the blood.

**Language of instruction:** English

**Teaching methods:**

- Script
- blackboard
- presentation with beamer
- experiments
- exercises

**Assessment methods:**

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

**Recommended reading:**

Manuscricpt (detailed), literature Medical Instrumentation; Application and Design; J. G. Webster, Editor; John Wiley & Sons, Inc.; New York

Medical Physics; J. R. Cameron, J, G, Skofronick; John Wiley & Sons, Inc.; New York

Bioelektrische Signale, Mayer-Waarden; Manuskript Universität Karlsruhe


Pulsoxymetrie- Fibel; B. Schöller, MCC GmbH; K. Forstner, Forschungsinstitut für klinische Medizintechnik (Asperg)

### 1.2.14 Imaging Systems in Medicine

**Course title:** Imaging Systems in Medicine

**Course code:** E2M192

**Type of course:** Lecture

**Level of course:** Master

**Degree Program:** Electrical Engineering

**Year of study:** First year

**ECTS Credits:** 2 CP

**Semester:** 2. semester

**Name of the lecturer:** Prof. Dr. Dieter Höpfel

**Course contents:** The content of this lecture are the most important tomography systems, used in medicine: Ultrasound, X-Ray Computer tomography, Nuclear Medicine (SPECT, PET) and Magnetic Resonance Imaging (MRI). The general topics and discussed questions for all these methods are: which sort of radiation is used, how is this radiation created, how does this radiation interact with the body, how is the radiation measured and how can one
create an image with the measured signal in the various method. Also important is the interpretation of the signal and the derived (digital) image. Finally the potential risks of each method are discussed and the question, which imaging method is for what application best suited.

Prerequisites:
Bachelor Degree

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

- understand the principles of the various imaging systems in Medicine. Especially they should understand how the used radiation is created, measured and how one gets an image with this signals. Also important is the question of their interaction with the human body and the consequences for the interpretation, i.e. what is really shown in the image? Finally they should have a conceivability of the risks and the advantages and disadvantages of each method.

Language of instruction:
English

Teaching methods:
- Script
- blackboard
- presentation with beamer
- experiments
- exercises

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

Recommended reading:
SPECT: SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY: A PRIMER;
ROMANS L. E.: INTRODUCTION TO COMPUTED TOMOGRAPHY, WILIAMS & WILKINS, ISBN: 0683073532,
HUBNER KARL F., COLLMANN J., BUONOCORE E., KABALKA G.: CLINICAL POSITRON EMISSION TOMOGRAPHY;
Dilcher, Venator, Dilcher: Handbuch der Kernspintomographie; Edwin Ferger Verlag

1.2.15 Project work

Course title: Project work
Course code: E2M120
Type of course: Project
Level of course: Master
Degree Program: Electrical Engineering
Year of study: First year
ECTS Credits: 8 CP
Semester: 2. 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: Bachelor

Course objectives expressed in learning outcomes and competences:

- establish specification
- structure a project
- establish time table
- make team discussion with minute keeping
- presentate 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
- [x] Presentation
- [ ] Project work
- [ ] Practical exercises

Recommended reading: