# English-taught courses for exchange students

**Winter Semester (WS) & Summer Semester (SS)**

## Faculty of Engineering (ING)

### Courses taught in English

#### Bachelor

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<th>Course No.</th>
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<th>WS/SS</th>
<th>Semester</th>
<th>Credit Points</th>
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#### Master

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<td>MG 01</td>
<td>Advanced Engineering Mathematics/ Angewandte Mathematik (AEngMaths)</td>
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MG Advanced mathematical/scientific basic modules

MG 01 Advanced Engineering Mathematics

Responsible for module: Professor Dr. Walter Häußler
Lecturer: Professor Dr. Schulze
Course: Master – ING M1-3
Frequency of module: Once a year - summer semester

Compulsory/FWPM: Semi-mandatory course in ENG-Master's program
Prerequisites: Knowledge of mathematical fundamentals
Language: English
Form of teaching: 70% lecture, 30% exercises

Workload:
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 30 hours
- Exercise preparation/follow-up: 40 hours
- Examination preparation: 20 hours
- Total workload: 150 hours

ECTS credits: 5
Examination: Written examination (90 minutes) in examination period
Material: Lecture notes, exercise problem descriptions, MatLab sample programs, demonstration of program results.

Objectives and Content:

Course objectives:

Goals: Knowledge of selected numerical algorithms and insight into the necessity of approximate solutions for real world engineering problems. Capability to assess limits of numerical methods.

Learning Objectives:
- Understanding of rounding errors and limited precision of numerical methods
- Assessing algorithmic variants with respect to their use, performance and reliability of results

Content overview


**Literature**

MG 02 Electrodynamics

**Responsible for module:** Professor Dr. Norbert Seliger

**Lecturer:** Professor Dr. Seliger

**Course:** Master ING M1-3

**Frequency of module:** Once a year - **summer semester**

**Compulsory/FWPM:** Semi-mandatory course in ENG-Master’s program

**Prerequisites:** Mathematics (analysis and geometry)
Electrical engineering (Electromagnetic fields), Matlab

**Language:** English

**Form of teaching:** 50% lecture, 50% exercises, 4 hours per week

**Workload:**
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 30 hours
- Exercise preparation/follow-up: 40 hours
- Examination preparation: 20 hours
- Total workload: 150 hours

**ECTS credits:** 5

**Material:** Lecture notes, worksheets available as download files

**Examination:** Written examination (90 minutes) in examination period

### Objectives and Content

**Course objectives**

**Goals:** The mathematical and physical principles of classical electrodynamics form the basis of all applications where the interaction of electromagnetic fields with technical systems is of importance, e.g. propagation of electromagnetic waves, antenna theory, electromagnetic compatibility (EMC) etc.

**Learning Objectives:** Introduction to vector analysis, Analysis of static and time-dependent electromagnetic fields and their interaction with electrical systems, Introduction to numerical methods and FEM software for the solution of practical electrodynamics problems.

### Contents

Review of vector analysis (coordinate transformations, scalar fields and vector fields, gradient, divergence, curl, laplacian operator, line, surface and volume integrals, Gauss, Stokes, Green’s theorems).

Electric fields of static charge distributions. Energy of charge distributions and of electric fields.

Magnetic fields of stationary current distributions. Lorentz force, vector potential, divergence and curl of magnetic fields. Time dependent electromagnetic fields. Faraday’s law of induction. Maxwell’s addition;

Literature

MG 03 Solid State Electronics

Responsible for module: Prof. Dr. Popp (I), Prof. Dr. Müller (II)

Course: Master ING M1-3

Frequency of module: Once a year - winter semester

Compulsory/FWPM: Semi-mandatory course in ENG-Master's program

Prerequisites: Working principles of electronic devices. Basic knowledge of the atomic structure of matter and electronic properties of materials. Knowledge of the fundamental mechanisms of interaction.

Language: English

Form of teaching: 75% lectures, 25% lab class, 4 hours per week

Workload:
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 40 hours
- Lab class preparation/follow-up: 30 hours
- Examination preparation: 20 hours
- Total workload: 150 hours

ECTS credits: 5

Material:
- Lecture notes, worksheets available as download files

Examination:
- Oral test (15 minutes) at end of lecture period

Objectives and Content

Course objectives

Goals:
- Enable students to understand the principles of quantum effect devices
- Give insight into fundamentals of nano technology

Contents

Part I (Popp)
- Fundamental principles of quantum mechanics. Bandgap engineering.
- Heterostructure devices and quantum effect devices.

Part II (Müller)
- Scanning probe microscopy: Working principle, interaction between sample and cantilever, modes of operation (contact, non-contact, tapping, MFM), structuring at a nanoscale.
- Scanning electron microscopy: Interaction electron beam with matter, EDX.
- Nano materials: Production methods, properties. Practical lab exercises.
Literature

Application notes from:
- Veeco Instruments [http://www.veeco.com]
- NT-MDT [http://www.ntmdt.com]
### MG 04 Statistics

**Responsible for module:** Prof. Dr. Wolfgang Bischof

**Course:** ING M1-3

**Frequency of module:** Once a year - winter semester

**Compulsory/FWPM:** Semi-mandatory course in ENG-Master’s program

**Prerequisites:** Knowledge of mathematical fundamentals

**Language:** English

**Form of teaching:** 70% lecture, 30% exercises, 4 hours per week

**Workload:**
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 30 hours
- Exercise preparation/follow-up: 40 hours
- Examination preparation: 20 hours
- Total workload: 150 hours

**ECTS credits:** 5

**Material:** Lecture notes, exercise problem descriptions, R sample programs, demonstration of program results

**Examination:** Written examination (90 minutes) in examination period

### Objectives and Content

**Course objectives**

**Goals:** Knowledge of the various statistical methods and a fundamental knowledge of probability calculus.

**Contents**

- Identify stochastic statistical aspects in every-day processes and issues, especially in technical and economic processes and issues.
- Gain a broad overview of basic descriptive and explorative methods of statistical data analysis and the possibilities resp. limits of its application.
- Acquire the foundations of probability theory and application of central inductive statistical methods.
- Be able to perform independently data analysis and to apply statistical methods using current statistics software (R). Knowledge and integration of the functionalities and features of popular statistics software packages.
- Gain the ability to independently acquire stochastic / statistical methods, to evaluate them critically and to implement them in practice using statistics software.
1. Applied Statistics
   • introduction
   • descriptive and explorative statistics
   • univariate analysis
   • multivariate analysis
   • inductive statistics
   • point estimation
   • interval estimation
   • testing of hypotheses
   • linear model

2. Principles of probability calculus

3. Statistics software: Introduction to data analysis with R

4. Tutorial assignments
   • theory and methods
   • statistics software (R)

Literature

MG 05 Fluid Mechanics

Responsible for module: Prof. Dr. Norbert Seliger/ Prof. Dr. Buttinger

Course: ING M1-3

Frequency of module: Once a year – summer semester

Compulsory/FWPM: Semi-mandatory course in ENG-Master’s program

Prerequisites: none

Language: English

Form of teaching: 50% lecture, 50% exercises, 4 hours per week

Workload: Lecture/class presence: 4 hours x 15 weeks = 60 hours
Lecture follow-up: 60 hours
Total workload: 120 hours

ECTS credits: 5

Material: Exercise problem descriptions, sample programs, demonstration of program results.

Examination: Written examination (90 minutes) in examination period (Mandatory participation on CFD computer exercises)

Objectives and Content

Course objectives

Goals: The course Fluid mechanics provides a basic introduction in fluid mechanics in theory and practice. Students gain competence in analytical problem understanding and enhance their problem solving capabilities in experiments and with numerical methods. In the computer exercises "CFD-simulations" students improve their skills by using modern computational fluid dynamics (CFD) software programs and they will be able to analyze complex fluid dynamics problems.

Contents
Fluid mechanics of real flows
Fluid mechanics of compressible non-viscous fluids
Fluid mechanics of viscous fluids
Introduction to CFD simulation
Simulation of compressible and incompressible fluids
Laboratory experiments and validation of CFD results

Literature
Einführung in die technische Strömungslehre, G. Junge, Hanser Verlag
Strömungsmechanik, H. Kuhlmann, Pearson Verlag
CFD-Modellierung: Grundlagen und Anwendungen bei Strömungsprozessen, R. Schwarze, Springer Vieweg Verlag
MA Application-based focus

MA 01 Real-Time Systems

**Responsible for module:** Prof. Dr. B. Mysliwetz (I), Prof. Dr. W. Schittenhelm (II)

**Course:** ING M1-3

**Compulsory/FWPM:** Semi-mandatory course in ENG Master's program

**Prerequisites:** Working principles of microprocessors (IO, interrupts, stack). Programming experience in a blockstructured high level language, preferably ANSI C or C++. Basic knowledge of structure and working principles of a 'general purpose' operating system. Fundamental knowledge of the functional units of a personal computer. Fundamentals of control theory.

**Language:** English

**Form of teaching:** 50% lectures, 50% lab class, 4 hours per week

**Workload:** Lecture/class presence: 4 hours x 15 weeks = 60 hours Lecture follow-up: 20 hours Lab class preparation/follow-up: 50 hours Examination preparation: 20 hours Total workload: 150 hours

**ECTS credits:** 5

**Material:** Lecture notes, worksheets and lab-class problem descriptions available as PDF download files

**Examination:** Lab class preparation tests (3x15 minutes, 10%) in part I plus written test (90 minutes, 90%) in examination period

**Objectives and Content**

**Course objectives**

**Goals:** To enable students to design and implement software for real-time applications.

**Learning Objectives:** At the end of this course, students will be able to:
- Understand the mechanisms and problems associated with real-time applications
- Apply real-time software design rules
- Know the working principles and utilize the services of real-time operating systems
- Realize the advantages of using real-time operating systems
Contents

Technical terms and definitions; examples of embedded real-time systems; real-time operating system concepts; processes, threads, tasks; scheduling principles; real-time software design; rate-monotonic scheduling approach; reentrant code: semaphores, mutual exclusion, shared resources; synchronization mechanisms; deadlocks; priority inversion; interprocess communication, overview of commercial real-time operating systems; practical laboratory exercises.

Lab (Part I)
Processes and Threads under Windows; Analysis of Fundamental Real-Time Properties of Windows on a PC; implementing a step motor control application with the real-time kernel ?C/OS on an ARM Cortex-M based microcomputer; application of semaphores as a mutual exclusion mechanism while accessing shared resources, effect of priority inversion.

Part II - PC-based Real-Time Control Systems (Schittenhelm)
Real-time applications based on personal computers: requirements, hardware and software design, overview and comparison of commercial PC-based systems.

Lab (Part II)
PC-based real-time systems via OPC-servers; Windows-CE development environment; real-time programming under VxWorks.

Literature
MA 02 Integrated Circuit System Design and Test

Responsible for module: Prof. Dr. Schinagl / Prof. Dr. Thurner / Prof. Dr. Versen

Course: ING M1-3

Frequency of module: Once a year – summer semester

Compulsory/FWPM: Semi-mandatory course in ENG-Master’s program

Prerequisites: Familiarity with digital logic and switching circuits; basic knowledge of a high level programming language.

Language: English

Form of teaching: Part I lectures (60%), Lab (40%) / 2,5 hours per week
Part II seminar (50%), Lab (50%) / 1,5 hours per week

Workload:
Part I
- Lecture/class presence: 2,5 hours x 15 weeks = 38 hours
- Lab class preparation: 18 hours
- Lecture follow-up: 18 hours
- Examination preparation: 18 hours
- Total workload for part I: 92 hours

Part II
- Lecture/class presence: 2 hours x 12 weeks = 24 hours
- Lab class preparation: 12 hours
- Lecture follow-up: 12 hours
- Examination preparation: 12 hours
- Total workload for part II: 60 hours

ECTS credits: 5

Material: Part I: Lecture notes, problem sheets and lab-class problem descriptions
Part II: Problem sheets and lab-class problem descriptions

Examination: Written test (90 minutes) at the end of the semester

Objectives and Content

Course objectives

Goals:
Part I
- To enable students to design complex digital circuits (ASICS or FPGAs) and systems using architecture optimization at RTL level, different synthesis steps and system simulation
- To enable students to verify and test IC systems and to use test system

Learning Objectives: At the end of this course, students shall be able to:
Part I
- Understanding the fundamentals of digital VLSI (or SoC) circuit design methodology.
- Optimizing architecture design at RTL level using equivalent transforms for combinational and sequential computations
• Design digital VLSI (or SoC) circuits using appropriate design tools to determine and optimize a RTL level architecture, to verify the model behavior by simulation and to synthesize the model into a FPGA.

Part II
• Understand the fundamental problems associated with fail observation and analysis
• Use of test systems and design for test methods to ensure system debug and product engineering

Contents

Part I – Design of Digital Integrated VLSI Circuits
Design methodology: modelling behaviour and structure using different levels of abstraction. Design flow, synchronous design. Architecture design and optimization at RTL level: Data dependency graph, isomorphic architecture, equivalent transforms for combinational computations, equivalent transforms for non-recursive sequential computations, unfolding of recursive sequential loops for LTI and linear time variant systems.

Part II – Test of Integrated Systems
Basic Function of Integrated Circuits, Failure and Defect Models, Observing and Detecting Failures, Fundamentals of Digital Test, Hardware Test Setups.

Literature

Part I
M.J.S.Smith: Application-Specific Integrated Circuits; Addison-Wesley; ISBN 0-205-50022-1
Mark Zwolinski: Digital System Design with VHDL; Prentice Hall; ISBN 0 20136063 2
Dirk Jansen: Handbuch der Electronic Design Automat-ion; Hanser Verlag; ISBN 3-446-21288-4
A.Mäder: VHDL Kurzbeschreibung; http://tech-www.informatik.unihamburg.de/VHDL/

Part II
MA 03 Mixed Signal Systems

Responsible for module: Prof. Dr. W. Mayr / Prof. Dr. Versen
Course: ING M1-3
Frequency of module: Once a year - summer semester
Compulsory/FWPM: Semi-mandatory course in ENG-Master’s program
Prerequisites: Good knowledge of the representation of continuous and time discrete signals in the time and frequency domain; fundamentals of digital signal processing, analogue and digital circuit design.
Language: English
Form of teaching: Part I lectures / 2 hours per week
Part II Seminar (50%), Lab (50%) / 2 hours per week
Workload:
Part I - Lecture
Lecture/class presence: 2 hours x 15 weeks = 30 hours
Lecture follow-up: 15 hours
Problem sheet solution: 15 hours
Examination preparation: 15 hours
Total workload for part I: 75 hours
Part II - Seminar and Lab
Seminar / lab presence: 2 hours x 15 weeks = 30 hours
Lab preparation: 15 hours
Presentation preparation: 15 hours
Examination preparation: 15 hours
Total workload for part II: 75 hours
ECTS credits: 5
Material: Book like lecture notes and problem sheets including detailed solutions.
Examination: Written test (90 minutes) at the end of the semester about the lectures and the seminar / lab.

Objectives and Content

Course objectives

Goals: To enable students to design mixed signal systems in a professional manner with respect to the properties of real world data converters.

Learning Objectives: At the end of this course, students shall be able to:
• Understand the fundamental problems associated with analogue to digital and digital to analogue conversion in real world mixed signal systems
• Assess the properties of data converters as given in the corresponding data sheets in order to select appropriate components for a mixed signal application
• Evaluate the properties of data converters and mixed signal systems by measurement and hardware characterization
Contents

Fundamentals of data conversion, discrete and fast Fourier transform including the use of windows, analogue and quantization noise, voltage references, static and dynamic properties of data converters, fast ADC and DAC architectures, mixed signal design guidelines.

Literature

MA 04 Assembly Technology

Responsible for module: Prof. Dr.-Ing. Christian Meierlohr

Course: ING M1-3

Frequency of module: Once a year – winter semester

Compulsory/FWPM: Semi-mandatory course in ENG-Master’s program

Prerequisites: Knowledge of assembly and manufacturing processes and manufacturing organization

Language: English

Form of teaching: 50% lecture, 50% exercises, 4 hours per week

Workload:
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 30 hours
- Exercise preparation/follow-up: 40 hours
- Examination preparation: 20 hours
- Total workload: 150 hours

ECTS credits: 5

Material: Handwritten lecture notes

Examination: Written examination (90 minutes) in examination period

Objectives and Content

Course objectives

- Have in-depth knowledge of joining techniques and procedures
- Be able to carry out the design of assembly systems with special attention to current strategies
- Have knowledge about and be able to optimize existing assembly systems

Contents

- Introduction and motivation for selected topics of assembly systems
- Joining techniques and procedures: forming, force fitting, welding/brazing, gluing
- Selected topics in handling technology
- Challenges in designing manual assembly systems
- Current developments of assembly systems
- Lean manufacturing in assembly
- Human-robot cooperation in assembly
- Cost-efficiency considerations in the assembly planning
- Optimization of assembly lines (with internship in model factory)

Literature

Lotter, Wiendahl: Montage in der industriellen Produktion, Springer Verlag, 2006
Hesse, Grundlagen der Handhabungstechnik, Hanser, 2012
Hesse, Greifertechnik, Hanser, 2011
Hesse, Taschenbuch Robotik, Montage, Handhabung, Hanser, 2010
Sommer, Taschenbuch automatisierte Montage- und Prüfsysteme, Hanser Verlag, 2008
MA 05 Free-Formed-Surfaces

Responsible for module: Prof. Dr.-Ing. Markus Lazar
Course: ING M1-3
Frequency of module: Once a year – winter semester
Compulsory/FWPM: Semi-mandatory course in ENG-Master’s program
Prerequisites: Knowledge of mathematical fundamentals 3D-CAD
Language: English
Form of teaching: 65% lecture, 35% project, 4 hours per week
Workload:
- Lecture/class presence: 4 hours x 10 weeks = 40 hours
- Lecture follow-up: 40 hours
- Exercise preparation/follow-up: 20 hours
- Project work: 50 hours
- Total workload: 150 hours
ECTS credits: 5
Material: Lecture notes, Software: CATIA, CAMWorks, Colin3D
Examination: Written examination; project work

Objectives and Content

Goals: Knowledge of principles in the development of products with freeform Surfaces.

Learning Objectives:
- Mathematic background of curves and surfaces
- Methods of designing freely shaped objects
- Methods of manufacturing freely shaped objects
- Inspection of freely shaped objects

Contents

1. Mathematical Background: Bezier Curves, B-Splines, NURBS
2. CAGD: Introduction to shape design with CATIA
3. Scanning Technologies
4. Reverse Engineering
5. CAD-CAM and 5-axes Machining
6. Rapid Prototyping

Literature

MA 07 Materials from Renewable Resources

Responsible for module: Prof. Dr. Johannes Schroeter
Course: ING M1-3
Frequency of module: Once a year - summer semester
Compulsory/FWPM: Semi-mandatory course in ENG-Master’s program
Prerequisites: Chemistry; Material Science
Language: English
Form of teaching: 50% lecture, 50% workshops, 4 hours per week
Workload:
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 30 hours
- Exercise preparation/follow-up: 40 hours
- Examination preparation: 20 hours
- Total workload: 150 hours
ECTS credits: 5
Material:
Lecture notes, worksheets available as download files
Examination:
Written examination (90 minutes) in examination period

Objectives and Content

Course objectives

Goals: Provide knowledge about materials, whose biomass feedstocks are provided by nature annually.

Learning Objectives:
- Definitions
- History of mankind’s use of materials from renewable resources (MFRR)
- Present impact
- Survey of materials

Contents

- Statutes, standards, guidelines, certification
- History of mankind’s use of MFRR (wood, natural fibres, leather, rubber, colourants)
- Present impact for the environment and for sustainable feedstock supply
- Present impact for the environment and for sustainable feedstock supply
- Survey of materials available (plastics/ non-plastics/ additives) Life cycle analysis

Literature

MV Advanced modules from the fields of Automation Technology, Communications Technology, Mechatronics, Mechanical Engineering, Plastics Engineering

MV 01 Advanced Control Systems

Responsible for module: Prof. Dr. W. Schittenhelm
Course: ING M1-3
Frequency of module: Once a year – summer semester
Compulsory/FWPM: Specialization subject in ENG Master’s program
Prerequisites: Classical control theory in time and frequency domain. Vector and matrix fundamentals.
Language: English
Form of teaching: 75% lectures, 25% lab class, 4 hours per week
Workload: Lecture/class presence: 4 hours x 15 weeks = 60 hours
Lecture follow-up: 25 hours
Lab class preparation/follow-up: 40 hours
Examination preparation: 25 hours Total workload: 150 hours
ECTS credits: 5
Material: Lecture notes, worksheets and lab-class problem descriptions available as PDF download files.
Examination: Written examination (90 minutes) in examination period

Objectives and Content

Course objectives

Goals: Enable students to design modern control systems.

Learning Objectives: At the end of this course, students will be able to:
• Apply state space descriptions to control systems
• Apply state space descriptions to control systems
• Analyse a system’s stability, controllability and observability
• Design state space controllers by pole placement
• Apply Fuzzy logic to control systems

Contents

State Space Control
State space description, solutions for the state space equations, analysis of state space description (stability, controllability, observability). State space controller design, controller structure, computation of the filter, computation of the controller matrix. State observer.
Non-linear control
Application of Fuzzy logic in control systems, fundamental ideas of Fuzzy logic, operations with Fuzzy sets, Fuzzy controller design, summary of advantages and disadvantages of Fuzzy control.

Literature

MV 02 Industrial Process Control

Responsible for module: Prof. NN

Course: ING M1-3

Frequency of module: Once a year - winter semester

Compulsory/FWPM: Specialization subject in ING Master’s program


Language: English

Form of teaching: 66% lectures, 33% lab class, 4 hours per week

Workload:
- Lecture/class presence: 6 hours x 15 weeks = 90 hours
- Lecture follow-up: 40 hours
- Lab class preparation/follow-up: 60 hours
- Examination preparation: 20 hours
- Total workload: 210 hours

ECTS credits: 5

Material: Lecture notes, worksheets and lab course descriptions available as download files. Videos, PPT-presentations, PC-simulations.

Examination: Written examination (120 minutes) in examination period

Objectives and Content

Course objectives

Goals: To enable students to design and implement solutions in industrial automation.

Learning Objectives: At the end of this course, students will be able to:
- Design and implement control functions for process and plant automation
- Evaluate different devices and methods
- Develop more complex PLC programs
- Evaluate the demands of field bus systems in automation technology and integrate them into more complex solutions
- Calculate the costs of installation and maintenance of automation plants
- Know about the parameterization and operation of an actuatorsensor network
- Design a safety network
Contents

• Structure and operation of a PLC system (SIMATIC S7).
• Application of the hardware configurator: Examples for parallel wired plants and fieldbus configurations. Characteristic parameters of CPU and signal modules.
• Program block structure in PLC technology. Program examples in FBD/LAD/STL. Application of bit logic, timer and counter instructions. Overview of further functions. Processing of analogue signals. Simulation and program test with PLCSIM.
• Programming sequential control functions with GRAPH7. Adaption of HMI Terminals.
• Levels of industrial communication. The ISO-OSI 7-layer model. Field bus structures and architectures. Comparison of different field bus systems. Realisation of an ASi-/ProfiBus configuration. Integration of safety requirements.

Literature

Phoenix Contact: Industrial Communication, Chapt 1-7, PPT Presentation
**MV 03 Electrical motion control**

**Responsible for module:** Prof. Dr. Hagl

**Course:** ING M1-3

**Frequency of module:** Once a year - **winter semester**

**Compulsory/FWPM:** Specialization subject in ENG-Master’s program

**Prerequisites:** Basic knowledge of time discrete control, mechanical transfer elements, MATLAB, electronics, DC-/ AC-motors.

**Language:** English

**Form of teaching:** 75% lecture, 25% lab class, 4 hours per week

**Workload:**
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 25 hours
- Lab class preparation/follow-up: 40 hours
- Examination preparation: 25 hours
- Total workload: 150 hours

**ECTS credits:** 5

**Material:** Lecture notes, documentation for lab classes.

**Examination:** Written examination (90 minutes) for both parts at the end of part II in examination period. *)

**Objectives and Content**

**Course objectives**

**Goals:** Enable students to design and commission electromechanical and direct driven servo drives. Selection of the different components for servo drives (Motion controller, power electronics, measuring systems and mechanical transfer elements). Optimization of controller parameters and contouring behavior.

**Learning Objectives:** Knowledge of static and dynamical behavior of different drive components and their interaction. Functional principles of motion controllers, including feed forward and filters. Specific characteristics of digital motion controllers. Optimization of parameter setting of motion controller. Understanding of field oriented control for 3-phase AC-motors without and with field weakening. Usage of simulation and engineering tools e.g. MATLAB and SIMULINK

**Contents**

Static and dynamical requirements. Control structures and motion profiles. Motion control of stiff drive systems, including influence of sample time and processing dead time. Simulation and engineering tools. Motion control of elastic drive systems. Feed forward and filters. Practical courses for drive simulation. Dynamical models of DC and AC drives including field oriented control. Interaction of motor and mechanics. Influence of axis controllers on contouring behavior. Influence of position
encoder. Practical exercises with drive systems.

**Literature**

Hans Groß, Jens Hamann, Georg Wiegärtner: Electrical Feed Drives in Automation, SIEMENS consumer publications, 2001, MLFB No. 6ZB3500-0AF02-0AA0
# MV 04 Automation Systems

<table>
<thead>
<tr>
<th>Responsible for module:</th>
<th>Prof. Dr. W. Schittenhelm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course:</td>
<td>ING M1-3</td>
</tr>
<tr>
<td>Frequency of module:</td>
<td>Once a year - <strong>winter semester</strong></td>
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<tr>
<td>Compulsory/FWPM:</td>
<td>Specialization subject in ENG-Master's program</td>
</tr>
<tr>
<td>Prerequisites:</td>
<td>Control theory in time domain. Familiarity with PLC- and Cprogramming.</td>
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<tr>
<td>Language:</td>
<td>English</td>
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<tr>
<td>Form of teaching:</td>
<td>50% lectures, 50% lab class, 4 hours per week</td>
</tr>
</tbody>
</table>
| Workload:              | Lecture/class presence: 4 hours x 15 weeks = 60 hours  
                          | Lecture follow-up: 25 hours  
                          | Lab class preparation/follow-up: 40 hours  
                          | Examination preparation: 25 hours  
                          | Total workload: 150 hours |
| ECTS credits:          | 5                        |
| Material:              | Lecture notes and lab-class problem descriptions available as PDF download files |
| Examination:           | Written examination (90 minutes) in examination period |

## Objectives and Content

### Course objectives

**Goals:** To enable students to apply modern robot control systems.

**Learning Objectives:** At the end of this course, students will be able to:
- Know the design of a robot control
- Programming an industrial robot
- Working with vision systems connected to a robot

### Contents

Construction of an IR, coordinate systems, algorithms for path generation, transformation algorithms, interpolation, position control, blocks of a robot control, programming of IR, handling devices.

### Literature

# MV 05 Reliability of Mechatronic Systems

**Responsible for module:** Prof. Dr. N. Seliger, Prof. Dr. M. Versen

**Course:** ING M1-3

**Frequency of module:** Once a year – **winter semester**

**Compulsory/FWPM:** Specialization subject in ENG-Master

**Prerequisites:** Statistics

**Language:** English

**Form of teaching:** Lecture 70 %, Exercises 30 %, Lab Course 0 %

**Workload:**
- Lecture/class presence (hours) 60
- Lecture follow-up (hours) 30
- Exercise preparation/follow-up (hours) 40
- Lab course (hours) 0
- Examination preparation (hours) 20
- Total workload (hours) 150

**ECTS credits:** 5

**Material:** Lectures notes and hardcopies and/or PDF download files for seminar class preparation

**Examination:** Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published by Examination Office

**Prerequisites:** Statistics

**Specific Goals:** To enable students to evaluate mechatronic systems under the aspects of reliability

**Learning Objectives:**
- Know different failure models
- Apply virtual qualification methods based on robustness validation concept
- Plan a test scenario for a given model, Setup/design reliable systems

**Topics:** Failure Modes, Defects & Testing of CMOS ICs, power devices, passive devices and electronic packaging, Failure Rate Models ESD, Reliability Analysis on case studies, e.g. ESD Test planning, Use of Redundancy and Monitors

**Material:** Lecture notes, examples and exercises available electronically.
Literature:
### MV 06 Wireless Communication Systems

**Responsible for module:** Prof. Dr. H. Stahl  

**Course:** ING M1-3  

**Frequency of module:** Once a year – **summer semester**  

**Compulsory/FWPM:** Specialization subject in ENG-Master’s program  

**Prerequisites:** Fundamentals of System Theory, Digital Modulation and Communication Protocols.  

**Language:** English  

**Form of teaching:** 67% lectures, 33% lab class, 3 + 1.5 hours per week  

**Workload:** Lecture/class presence: 4.5 hrs x 15 weeks = 72.5 hrs  
Lecture follow-up: 27.5 hours  
Lab class preparation/follow-up: 30 hours  
Examination preparation: 20 hours  
Total workload: 150 hours  

**ECTS credits:** 5  

**Material:** Lecture notes, worksheets and lab-class handouts are available in hardcopy or PDF  

**Examination:** Written examination (90 minutes)  

### Objectives and Content

#### Course objectives

**Goals:** Understanding the structure and the underlying transmission techniques of current wireless communication systems and networks. Analysis and assessment of services, components, and protocols of wireless networks.  

#### Contents

**Lecture MV06.1:**  
Basics of wireless communication: Propagation and wireless channel characteristics; link budget; cellular systems. Current wireless communication standards:  
- Networking: VoIP-Standards SIP  
- PLMNs: LTE  
- Digital TV: The DVB-T standard  
- WLANs: IEEE 802.11 family. Introduction of transmission techniques: OFDM, and OFDM-A.  

**Lab Class MV06.2:**  
Exercises on  
- Voice over IP  
- LTE RF Measurements and Protocol Analysis  
- DVB-T channel and signal analysis.
Literature

M. Sauter: Grundkurs Mobile Kommunikationssysteme UMTS, HSDPA und LTE, GSM, GPRS und Wireless LAN. Vieweg+Teubner, Wiesbaden, 2011 (available in German as eBook)
**MV 07 Advanced Digital Communications**

**Responsible for module:** Prof. Dr. Markus Stichler  
**Course:** ING M1-3  
**Frequency of module:** Once a year – **summer semester**  
**Compulsory/FWPM:** Specialization subject in ENG-Master’s program  
**Prerequisites:** Basics of system theory and digital signal processing.  
**Language:** English  
**Form of teaching:** 75% lectures with integrated exercises, 25% lab course, 4 hours per week  
**Workload:** Lecture/class presence: 4 hours x 15 weeks = 60 hours  
Lecture follow-up: 25 hours  
Lab class preparation/follow-up: 40 hours  
Examination preparation: 25 hours  
Total workload: 150 hours  
**ECTS credits:** 5  
**Material:** Lecture notes, worksheets and lab class handouts are available in hardcopy and PDF  
**Examination:** Written examination (90 minutes) in examination period  

**Objectives and Content**  

**Course objectives**  

**Goals:** Understanding of the basics of digital communication systems; concepts of modern digital communication systems: OFDM and CDMA.  

**Contents**  

**Lecture**  
Basics of digital communication systems: Modulation, mobile communication channel, time variant multi-path propagation, demodulation, synchronization, channel estimation and equalization.  
Concepts of modern mobile communication systems: OFDM, basics, synchronization, equalization. CDMA, basics, synchronization, equalization.  

**Lab Class**  
Simulation of methods and algorithms used in digital communication systems with tools like e.g. MatLab  

**Literature**  
MV 08 Digital Signal Processing

Responsible for module: Prof. Dr. Markus Stichler
Course: ING M1-3
Frequency of module: Once a year – winter semester
Compulsory/FWPM: Specialization subject in ENG-Master’s program
Prerequisites: Fundamentals of system theory
Language: English
Form of teaching: 75% lectures with integrated exercises, 25% lab course, 4 hours per week

Workload:
- Lecture/class presence: 4 hours x 15 weeks = 60 hours
- Lecture follow-up: 25 hours
- Lab class preparation/follow-up: 40 hours
- Examination preparation: 25 hours
- Total workload: 150 hours

ECTS credits: 5
Material: Overhead, board, beamer
Examination: Written examination (90 minutes) in examination period

Objectives and Content

Course objectives

Goals: Advanced knowledge in applied digital signal processing with view on applications in the areas of information- and communication technology as well as control technology.

Contents

Lecture
Deterministic and stochastic signals and systems, discrete Fourier- and Wavelet-Transformation, LTI systems, design and implementation of digital systems, sample rate conversion, multirate signal processing.

Lab Class
Design, simulation (using MatLab and/or Simulink) and implementation of simple algorithms on digital signal processors (DSPs) and/or FPGAs.

Literature
Oppenheim, Schafer: Discrete-Time Processing, Prentice Hall, 1992
### MV 09 Advanced FEM

**Responsible for module:** Prof. Dr.-Ing. S. Schinagl

**Course:** ING M1-3

**Frequency of module:** Once a year – **winter semester**

**Compulsory/FWPM:** Specialization subject in ENG-Master’s program

**Prerequisites:** Strength of materials, FEM basics

**Language:** English

**Form of teaching:** 50% lectures, 50% practical training, 4 hours per week

**Workload:**
- Lecture presence: 2 hours x 15 weeks = 30 hours
- Lecture follow-up: 20 hours
- Practical training presence: 2 hrs x 15 weeks = 30 hours
- Practical training follow-up: 20 hours
- Examination preparation: 50 hours
- Total workload: 150 hours

**ECTS credits:** 5

**Material:** Lecture notes and hardcopies and/or PDF download files

**Examination:** Written examination

### Objectives and Content

**Course objectives**

**Goals:** To enable students to evaluate mechatronic systems with respect to their mechanical behavior and reliability.

**Learning Objectives:** At the end of this course, students will know about theoretical basics and have practical competences to:
- analyse nonlinear structural mechanic problems considering all kinds of nonlinearities (geometry, material, contact)
- work in the field of modal based linear structure dynamical analyses
- strength verification

**Contents**

Fundamentals of numerical modeling and analysis of nonlinear structural problems
- Modal based linear dynamics: Natural frequencies and mode shapes, frequency response analysis / harmonic analysis, response spectrum analysis
- Strength verification: Influence factors on static strength and fatigue strength, concepts of strength verification with local stresses
Literature

Analytical Strength Assessment of Components, FKM Guideline. VDMA Verlag, 2013
# MV 10 Electromagnetic Compatibility

**Responsible for module:** Prof. Dr. Norbert Seliger

**Course:** ING M1-3

**Frequency of module:** Once a year – winter semester

**Compulsory/FWPM:** Specialization subject in ENG-Master’s program

**Prerequisites:** Knowledge in electromagnetic fields, transmission lines, electrical signals and circuit components

**Language:** English

**Form of teaching:** 70% lectures, 30% lab class, 4 hours per week

**Workload:**
- Lecture presence: 2 hours x 15 weeks = 30 hours
- Lecture follow-up: 20 hours
- Practical training presence: 2 hrs x 15 weeks = 30 hours
- Practical training follow-up: 20 hours
- Examination preparation: 50 hours
- Total workload: 150 hours

**ECTS credits:** 5

**Material:** Lecture notes and problem sheets

**Examination:** Written examination (90 minutes) in examination period

## Objectives and Content

### Course objectives

**Goals:** Within this lecture students will learn the basics of EMC engineering and its application in early system design. By discussing case studies and lab experiments we will bridge the gap between theory and practical implementation.

**Learning Objectives:** Understanding of basic aspects of EMC: theory of emission and reception of conducted and radiated electro-magnetic interference signals, coupling mechanisms and their models. Design methods and techniques for EMC compliance: PCB and circuit design, grounding, filter design, signal spectra, system design, shielding aspects. EMC measurement techniques and EMC standards

### Contents

- Introduction to EMC and EMI phenomena
- Basic concepts (conducted and radiated emission and susceptibility)
- Electrical signals and their spectra
- Propagation and crosstalk, coupling, EMC modeling
- Interference control techniques (PCB and circuit design, shielding, grounding, filter design)
- EMC measurements and EMC Standards
- Case studies and Lab experiments
Literature

Paul: Introduction to EMC, Wiley 2006
Ott: EMC Engineering, Wiley 2009
Franz: EMV, Vieweg+Teuber 2008
Christopoulos: Principles and Techniques of EMC, CRC Press
Montrose, Nakauchi: Testing for EMC Compliance, Wiley 2004
Schwab: Elektromagnetische Verträglichkeit, Springer 2007
Dhia, Ramdani, Sicard: EMC of Integrated Circuits, Springer 2006
MV 11 Image Processing for Automated Production

Responsible for module: Prof. Dr. Michael Wagner
Course: ING M1-3
Frequency of module: Once a year – summer semester
Compulsory/FWPM: Specialization subject in ENG-Master’s program
Prerequisites: Familiarity with basic matrix calculations
Language: English
Form of teaching: 50% lectures, 50% lab class, 4 hours per week

Workload:
Lecture/class presence: 2 hours x 15 weeks = 30 hours
Lab class presence: 4 hours x 8 weeks = 32 hours
Lecture follow-up: 15 hours
Lab class preparation/follow-up: 30 hours
Case study: 15 hours
Examination preparation: 28 hours
Total workload: 150 hours

ECTS credits: 5
Material: Lecture notes and problem sheets
Examination: Written Test (90 minutes) at the end of the semester

Objectives and Content

Course objectives

Goals: Students will be enabled to
• select suitable hardware components for a given imaging problem,
• calibrate the optical system,
• design, test and optimize the network of imaging operators by using a GUI imaging toolkit,
• create a graphical user interface,
• establish a complete industrial application by generating sequences for operator execution and data exchange.

Learning Objectives: During this course, students will gain knowledge in:
• Types of cameras, data formats, optics, illuminations,
• two dimensional algorithms in image enhancement, extraction and localization of features, classification of features,
• 2d and 3d transformations,
• 2d and 3d camera calibration,
• creation of industrial imaging applications by using a GUI (graphical user interface) imaging toolkit.
Contents

• Camera types, image- and data formats, optics, illuminations, optical filters.
• Binary image morphology.
• Image enhancement: Noise reduction filters, grey value scaling, thresholding.
• Digital Fast Fourier Transform (DFFT).
• Extraction of edges and ridges.
• Pattern matching.
• Shape analysis.
• Hough Transform and Generalized Hough Transform (GHT) for object localization.
• Classifiers, especially Neural Network Classifiers.
• Texture analysis.
• 2d transforming of images and masks.
• 2d camera calibration, internal and external camera parameters.
• 3d camera calibration.
• 3d object localization.
• 3d line section based surveying.

Literature

**MV 12 Mechanical Design**

**Responsible for module:** Prof. Dr. Michael Wagner

**Course:** ING M1-3

**Frequency of module:** Once a year – **summer semester** (block course May/June)

**Compulsory/FWPM:** Specialization subject in ENG-Master’s program

**Prerequisites:** A minimum of 15 credits minimum in mechanical drawing and CAD (bachelor level) and knowledge in one of the following skills: FEM, statistical tolerance calculation, free form surface CAD, sheet metal CAD.

**Language:** English

**Form of teaching:** 10% seminar, 80% project work, 10 work hours per week

**Workload:**
- seminar attendance: 4 hours x 4 weeks = 16 hours
- team project work 40 hours
- individual project work 86 hours
- final presentation 8 hours
- Total workload: 150 hours

**ECTS credits:** 5

**Material:** Literature in the library and on the internet, standards, patents, software tools and methods (DFMA, CAD, FEM, statistical tolerance calculation)

**Examination:** Student work, final presentation

**Objectives and Content**

**Course objectives**

**Goals:** The students will have a practical knowledge of and ability to develop, design and optimize technical, mainly mechanical products in a conflicted area of complex requirements. The students will have experience in project management.

**Learning Objectives:** Various complex design tasks are given to student teams. The teams have to plan and execute the development and design tasks independently under supervision of professors and engineers. Depending on the task, the teams use supporting tools and methods for mechanical design such as
- advanced CAD (free form surface, sheet metal design, motion assembly)
- DFMA (Design for Manufacturing and Assembly) method
- FEM (Finite Element Method)
- creative design methodologies
- industrial design basics
- arithmetic and statistical tolerance calculations
- project management
- prototyping and testing
At the end, all product documents are to be submitted and a final presentation is to be given in a concluding seminar meeting.

Contents

• Design methodologies
• Optimizing for assembly and manufacturing
• Design project management
• Advanced design tools
• Product documentation
• Tolerance calculations

Literature

VM 18 Selected topics of Polymer Chemistry and Materials Sciences

Responsible for module: Prof. Dr. D. Muscat / Prof. Dr. M. Müller

Course: ING M1-3

Frequency of module: Once a year – winter semester

Compulsory/FWPM: Specialization subject in ENG-Master’s program

Prerequisites: none

Language: English

Form of teaching: 50% lecture, 50% exercises, 4 hours per week

Workload: Lecture/class presence: 4 hours x 15 weeks = 60 hours
Lecture follow-up: 30 hours
Exercise preparation/follow-up: 30 hours
Examination preparation: 30 hours Total workload: 150 hours

ECTS credits: 5

Examination: oral / written examination

Objectives and Content

Course objectives

Part I:

Caoutchoucs, Plastics, Reaction-mechanisms Understanding
1. types and production of caoutchoucs, vulcanization and production of rubbers
2. novell networks based on pericyclic reactions (Diels Alder reactions)
3. analysis of Plastics

Part II:

Microscopy and Nanomaterials Understanding the working principles of
1. scanning probe microscopes
2. scanning electron microscopes (SEM + EDX)
3. properties of nanomaterials - first principles

Contents

Part I

The first part introduces the different types of caoutchoucs and their nomenclature. Typical examples are explained. The vulcanization of caoutchoucs and the production of tires as the major example in the rubber field are discussed. Besides classical rubbers new polymer networks based on pericyclic reactions are introduced. Therefore, first the Diels Alder reaction is explained and then the use of this reaction in polymeric networks is
regarded. For a better understanding of the analysis of plastics an overview of applied techniques is given and some examples are discussed in detail.

Part II

The second part gives an short review of different methods of microscopy, especially how to analyse materials and structures at the nanoscale. SPM's were discussed in detail, SEM and EDX more generaly. The very special properties of nanomaterials were discussed in order to understand their first principles, several concrete material systems and structures at the nanoscale were discussed.

Literature

Makromoleküle, Band 1 und 2, Hans Georg Elias, Verlag Hüttig und Wepf, Basel
J. I. Goldstein, Scanning Electron Microscopy and X-Ray Microanalysis
E.L. Wolf, Nanophysics and Nanotechnology
B. Bushan, Handbook of Nanotechnology
D. Sarid Scanning Force Microscopy, Oxford University Press, New York
1991 H. Fischer, Web-Publikationen der Firmen Bruker und NT-MDT
MF Specialist required elective courses

MF 01 Microelectronics

Responsible for module: Prof. Dr. Popp
Course: ING M1-3
Frequency of module: Once a year - summer semester
Compulsory/FWPM: Technical elective course in ING Master’s program.
Language: English
Form of teaching: 50% lectures, 50% lab class, 4 hours per week
Workload: Lecture/class presence: 4 hours x 15 weeks = 60 hours
Lecture follow-up: 15 hours
Lab class preparation/follow-up: 60 hours
Examination preparation: 15 hours
Total workload: 150 hours
ECTS credits: 5
Material:
Examination: Oral test (20 minutes) at end of lecture period

Objectives and Content

Course objectives
Enable students to understand the principles of full custom design and fabrication of integrated circuits.

Contents

Lecture:
Semiconductor technology (layer growth, doping, masking, mounting).
MOS- and BIP-Circuit integration, layout-rules, dimensioning with typical examples.

Lab class:

Literature
MF 03 Advanced OpAmp Circuit Design

Responsible for module: Prof. Dr. Prof. Dr. Mayr

Course: ING M1-3

Compulsory/FWPM: Technical elective course in the ING Master’s program.

Prerequisites: DC and AC circuit analysis at an advanced level. Fundamental knowledge of circuit design and linear control theory.

Language: English

Form of teaching: Lecture and lab class, 4 hours per week

Workload: Lab/class presence: 4 hours x 15 weeks = 60 hours. Lecture follow-up: 15 hours. Lab preparation/follow-up: 60 hours. Exam preparation: 15 hours. Total workload: 150 hours.

ECTS credits: 5

Material: Book like lecture notes and problem sheets including detailed solutions description of lab experiments.

Examination: Written test (90 minutes) at the end of a semester.

Objectives and Content

Course objectives

Goals: To enable students to develop operational amplifier circuits at a professional level.

Learning Objectives: At the end of this course, students shall be able to:
- understand the properties of real world operational amplifiers and their influence on the performance of a circuit.
- to design professional operational amplifier circuits including DC circuits, active filters, power and rectifier stages and linear control circuits.
- calculate the noise in operational amplifier circuits.

Contents

- Fundamentals of op amp circuits
- Non ideal properties of real world op amps and their influence on circuit performance
- Feed back and stability
- Frequency response of op amp circuits
- Rectifier and power circuits
- Design of active filters
- Linear control circuits
- Noise in op amp circuits

Literature

MF 10 Microelectronics Packaging

Responsible for module: Prof. Dr. Wolfgang Radlik

Course: ING M1-3

Frequency of module: Once a year - summer semester

Compulsory/FWPM: Technical elective course in ING Master’s program

Language: English

Form of teaching: Lecture, 2 hours per week

Workload: Lecture/class presence: 2 hours x 15 weeks = 30 hours
Lecture follow-up: 15 hours
Examination preparation: 15 hours
Total workload: 60 hours

ECTS credits: 2

Material: Lecture notes, multimedia presentations

Examination: Written test (60 minutes) at end of lecture period

Objectives and Content

Course objectives

Goals: Students shall be enabled to select appropriate packaging technologies to implement functional hardware and to assess its impact on system performance.

Learning Objectives: Common technologies for mounting semiconductor components on carriers and for providing electrical interconnections. Technologies for substrate configuration, component assembly, high density interconnection and encapsulation including relevant application examples. The students should be able to identify and to assess the interdependencies between circuit design, miniaturization issues, system performance and packaging technology.

Contents

Challenges and definitions of microelectronics packaging, IC backend manufacturing processes,

• First-level packaging: Integrated circuit packaging and interconnection
  – Lead frames, die bonding
  – Wire bonding
  – Tape automated bonding
  – IC plastic packages

• Second-level packaging: substrates
  – Wiring capacity, Rent’s rule, impedance control
  – Single and multilayer printed circuit boards
  – Multilayer cofired ceramic technology
  – Thin film technology

• Second-level packaging: board assembly processes
  – Through Hole Technology (THT)
  – Surface Mount Technology (SMT)
• Area array packages
  – Ball Grid Arrays (BGA)
  – Chip Size Packages (CSP)
  – Flip Chip Technology (FC)
15. Functional Tests
16. Array Diagnostics – Bitmapping
17. Array Periphery Diagnostics

Literature

MF 13 Programming of Communication Applications using LabVIEW

Responsible for module: Prof. Dr. H. Stahl
Course: ING M1-3
Frequency of module: Once a year – summer semester
Compulsory/FWPM: Technical elective course in ENG-Master
Prerequisites: A minimum of 15 credits minimum in mechanical drawing and CAD (bachelor level) and knowledge in one of the following skills: FEM, statistical tolerance calculation, free form surface CAD, sheet metal CAD.

Language: English
Form of teaching: Lecture 30 %, Exercises 0 %, Lab Course 70 %
Workload:
- Lecture/class presence (hours) 60
- Lecture follow-up (hours) 40
- Exercise preparation/follow-up (hours) 0
- Lab course (hours) 25
- Examination preparation (hours) 25
- Total workload (hours) 150

ECTS credits: 5

Material: Literature in the library and on the internet, standards, patents, software tools and methods (DFMA, CAD, FEM, statistical tolerance calculation)

Examination: Type and duration according to Study Regulation (SPO), updated at the beginning of each term, announcements published by Examination Office

Prerequisites: This is not a teaser course "Programming for Beginners"! Skills in C, C++, C#, Java or LabVIEW will be verified by a short test during the 1st lecture. In case of overbooking, the actual study progress (i.e. the cumulated Credit Points) will be used as an admission criterion as well.

Specific Goals: Ability to design and program key applications for measurement, digital signal acquisition/processing and data communication. Understanding the software architecture of a modern Real-Time communication system.

Learning Objectives: This seminar teaches programming - with the focus on practical applications. In the second half of the seminar, students will create communication applications that employ the existing TCP/IP protocol stack, and they will meet and modify the inards of an advanced wireless communication system, see www.etz.de/files/074_stahl-stichler.pdf for more.
**Topics:**
LabVIEW Programming fundamentals, based on practical examples and exercises Client and Server Communication using TCP/IP Exploring and modifying the behaviour of a distributed Wireless Real-Time Communication System

**Material:**
Lecture notes, examples and exercises available electronically.

**Literature:**
R. Bishop: LabVIEW 8 Student Edition. Prentice Hall, , Upper Saddle River, NJ, USA
W. Georgi: Einführung in LabVIEW. Hanser Fachbuchverlag, Leipzig, Germany
MF 12 Satellite Navigation

Responsible for module: Prof. Dr. Birger Mysliwetz

Course: ING M1-3

Frequency of module: Once a year - winter semester

Compulsory/FWPM: Technical elective for ING- and INF-Master’s program

Prerequisites: Basic linear algebra, analysis and statistics. Basics of electrodynamics (wave propagation). Proficiency in a programming language to solve homework problems (mostly linear algebra problems).

Language: English

Form of teaching: 50% lectures, 50% exercises, 4 hours per week

Workload:
- Lecture/class presence: 2 hours x 15 weeks = 30 hours
- Exercises: 2 hours x 15 weeks = 30 hours
- Lecture follow-up/homework assignments: 60 hours
- Examination preparation: 30 hours
- Total workload: 150 hours

ECTS credits: 5

Material: Lecture notes

Examination: Written test (60 minutes) at end of lecture period

Course objectives

Goals: To enable students to assess the applicability of satellite navigation for a given problem.

Learning Objectives: At the end of this course, students will:
- Understand the principles of satellite navigation
- Know the limitations of satellite navigation

Contents

At the end of this course, students will: Understand the principles of satellite navigation, know the limitations of satellite navigation

Literature

Elliott D. Kaplan: Understanding GPS Principles and Applications, Artech House Publisher
Gilbert Strand, Kai Borre: Linear Algebra, Geodesy, and GPS, Willesley-Cambridge Press
MF 14 Power Electronic Circuit Design

Responsible for module: Prof. Dr. Norbert Seliger

Course: ING M1-3

Frequency of module: Once a year - summer semester

Compulsory/FWPM: Technical elective course in ING Master’s program

Prerequisites: Knowledge in power electronics, electrical circuits, semiconductor devices, Matlab/PSPICE basics

Language: English

Form of teaching: 80% lectures, 20% lab class, 2 hours per week

Workload: Lecture/class presence: 2 hours x 15 weeks = 30 hours
Lecture follow-up: 20 hours
Lab class preparation/follow-up: 20 hours
Examination preparation: 20 hours
Total workload: 90 hours

ECTS credits: 3

Material: Lecture notes, worksheets available as PDF downloads

Examination: Written examination (90 minutes) in examination period

Objectives and Content

Course objectives: Design of complex power electronic circuits based on specifications. Ability to select the proper topology and calculate and simulate (Matlab, PSPICE) voltage and current transients in power semiconductor elements and passive components. Layout rules for power electronic circuits. Cooling solutions, thermal management. Interfacing with digital signal processing.

Contents

• Topology Selection
• Circuit Design
• Losses in Power Semiconductors
• Power Passives (Inductors, Transformers, Capacitors)
• Simulation (MatLab, PSPICE)
• Layout, Isolation Coordination
• Thermal Design (Thermal Impedance, Thermal Management)
• Reliability Issues
• Case studies and Lab experiments

Literature

MF 20 RF and Microwave Systems

**Responsible for module:** Prof. Dr. Markus Stichler

**Course:** ING M1-3

**Frequency of module:** Once a year - winter semester

**Compulsory/FWPM:** Technical elective course in ING Master’s program

**Prerequisites:** none

**Language:** English

**Form of teaching:** 50% lectures, 50% exercises, 2 hours per week

**Workload:**
- Lecture/class presence: 1 hours x 15 weeks = 15 hours
- Exercises: 1 hours x 15 weeks = 15 hours
- Lecture pre-class and post-class study 40 hours
- Examination preparation: 20 hours
- Total workload: 90 hours

**ECTS credits:** 3

**Material:** The course is based mainly on reference A, in particular chapters 2-4. Additional material may also be sourced from references B-G. Students should be able to derive their notes from course lectures.

**Examination:** Homework assignments & written examination (90 minutes)

Objectives and Content

**Course objectives**
1. Develop an overall picture of radio and microwave systems, primarily for communications.
2. Understand performance requirements and how they relate to system specifications.
3. Learn about various transceiver architectures, their merits and costs.
4. Derive system specifications from wireless communication standards.
5. Calculate an end-to-end link budget, develop a level plan and create system level behavioural models.

**Contents**

1. Modulation, Transmitters and Receivers
   - Receiver, transmitter and transceiver architectures, RF signals, Analogue modulation, Digital modulation, Interference and distortion, Early receiver technology, Modern transmitter architectures, Modern receiver architectures
2. Antennas and the RF Link
   - RF antennas, Radiation from a current filament, Resonant antennas, Traveling-wave antennas, Fundamental antenna parameters, The RF link, Radio link interference
3. RF Systems
   - Broadcast, simplex, duplex, diplex and multiplex operations, Cellular communications, Multiple access schemes, Spectrum efficiency, Cellular phone systems, Generations of radio, 4G, fourth
generation radio: beyond 3G and Long Term Evolution, 5G, fifth generation radio: beyond 4G
Radar systems introduction

Literature

MF 22 Kalman Filtering in Control Systems and Communications Applications

<table>
<thead>
<tr>
<th>Semester</th>
<th>ING M1-3 (winter term)</th>
</tr>
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<tbody>
<tr>
<td>Coordinator/Responsibility</td>
<td>Prof. Dr. B. Mysliwetz &amp; Prof. Dr. M. Stichler</td>
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<tr>
<td></td>
<td>Teacher Prof. Dr. B. Mysliwetz &amp; Prof. Dr. M. Stichler</td>
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<tr>
<td>Language</td>
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<td>Position in Curriculum</td>
<td>Technical elective course in ING Master’s program</td>
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<tr>
<td>Course Type / Weekly Hours</td>
<td>25% lectures, 75% lab/project work, 4 hours per week</td>
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<tr>
<td>Workload</td>
<td>Duration 1 semester</td>
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<td></td>
<td>Lecture/class presence: 2 hours x 15 weeks = 30 hours</td>
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<tr>
<td></td>
<td>Lab project work: 2 hours x 15 weeks = 30 hours</td>
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<td></td>
<td>Lab project preparation: 60 hours</td>
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<td></td>
<td>Final presentation preparation: 30 hours</td>
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<td></td>
<td>Total workload: 150 hours</td>
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<td>Credits</td>
<td>5</td>
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<tr>
<td>Prerequisites</td>
<td>Familiarity with MATLAB and C (or C++) programming.</td>
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<td></td>
<td>Course MV01 Advanced Control Systems is strongly recommended.</td>
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Specific Goals / Learning Objectives

Teaching Goals
Enable students to understand the working principles and application areas of recursive estimation methods and to design and implement numerically efficient and stable algorithms for state and parameter estimation. Practical implementation and analysis is done within a lab project.

Learning Objectives
at the end of this course, students will
- Know application areas of state and parameter estimation approaches
- Understand central working principles and algorithms of recursive estimation methods
- Be aware of potential numerical problems and the computational load of different mathematical formulations of KF algorithms
- Gain hands-on application experience in KF design, filter tuning and embedded implementation

Topics
- Introduction - Background, Motivation and Application Fields of Kalman Filtering
- Mathematical Fundamentals - Matrix Algebra Basics, Linear Systems Theory, Discretization
✓ Probability Theory Fundamentals - Random Variables, Stochastic Processes, White Noise
✓ State Space Model of a Dynamic System - Continuous-Time vs. Discrete Time, State Observer, Observability
✓ Least Squares Estimation
✓ Propagation of States and Covariances
✓ The Discrete-Time Kalman Filter
✓ Alternate Filter Formulations - Factorization, Square Root Filters, Nonlinear/Extended Kalman Filter
✓ Special Topics - Resolving Numerical/Stability Problems, Filter Tuning
✓ Practical Lab Projects/Exercises e.g.: Position- and Motion-Estimation from Image Processing Data, Carrier Phase Recovery in a Receiver/Demodulator, Position- and Motion-Estimation for Inertial Navigation

Material
Lecture notes, worksheets and lab-class problem descriptions available as PDF download files

Literature
**MF 23 Design of Materials**

<table>
<thead>
<tr>
<th>Semester</th>
<th>ING M1-3 (summer term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinator/Responsibility</td>
<td>Prof. Dr. Norbert Seliger/ Prof. Dr. Strübbe</td>
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<td>Language</td>
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<td>Specialization subject in ENG-Maste</td>
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<td>Lecture follow-up (hours) 20</td>
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<td>Exercise preparation/follow-up (hours)</td>
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<td>Lab course (hours) 60</td>
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<td>Examination preparation (hours) 40</td>
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<td>Total workload (hours) 150</td>
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<tr>
<td>Credits</td>
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<tr>
<td>Prerequisites</td>
<td>Basic course in polymer chemistry and extrusion</td>
</tr>
</tbody>
</table>

**Specific Goals / Learning Objectives**

**Teaching Goals**

Students should learn how to design/achieve specific needed material properties, e.g. corrosion protection, scratch resistance, low shrinkage in thermoplastics, elastomers as well as in paints and coatings.

**Learning Objectives**

To gain the knowledge and competence how to use fillers and additives in plastics or how to create material combinations (plastic - plastic, wood - plastic, metal - plastic, etc) to achieve enhanced material/composite properties. KF design, filter tuning and embedded implementation.

**Topics**

- Definition of terms: additives, pigments, fillers
- Additives in General
  - Polymer Compounds
  - Fillers: Classification of Fillers, Particle morphology of Fillers, Fillers and their function, Rules of Mixtures, Effect of Filler, Form of Filler, Dispersing and Grinding, Interaction between particles
  - Methods for particle incorporation
  - Extrusion
  - Dissolver
  - Triple roll mill
  - High Speed agitator ball mill
- Application examples and recipes in thermoplastics, paints and coatings and elastomers
- Methods for testing specific filler properties e.g. color, oil absorption; Methods
for testing specific application properties e.g. scratch resistance, corrosion protection;

**Material**

Creation of own extruder screw configuration Lecture notes, worksheets and lab-class problem descriptions available as PDF download files

**Literature**

*Füllstoffe, Ceresana: Market Study 2016  
*Polymer Engineering, Peter Eyerer, Thomas Hirth, Peter Elsner, Springer Verlag, Heidelberg, 2008  
*Nanocomposites, Deutsche Forschungsgemeinschaft (DFG), D. Walter, Primary Particles ? Agglomerates ? Aggregates, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2013  
*Dispergieren von Pigmenten und Füllstoffen, J. Winkler, Hannover: Vincentz Network, 2010;  