Modulhandbuch

für den

Master-Studiengang Mechatronics

getragen von den Departments
„Elektrotechnik und Informatik“ und „Maschinenbau“
der Fakultät IV (Naturwissenschaftlich-Technische Fakultät)

Stand: 26.07.2013

Inhalt

1. Vorbemerkungen

1.1 Zweck und Einordnung dieses Dokuments

Das hier vorliegende Modulhandbuch ist Teil der Unterlagen zum Akkreditierungsantrag für die Studiengänge im Department Elektrotechnik und Informatik. Die kompletten Unterlagen zum Akkreditierungsantrag bestehen aus:

1. einem Leittext, der folgende Themen behandelt:
   a. die Konzeption der Bachelor- und Masterstudiengänge mit Angaben zu
      i. dem abgedeckten Sektor des Arbeitsmarkts,
      ii. wählbaren Vertiefungsmodulen,
      iii. Verlaufsplänen bzw. Empfehlungen, in welcher Reihenfolge die Module studiert werden können
   b. eine Darstellung der personellen und sachlichen Ressourcen des Fachbereichs, die für die Studiengänge zur Verfügung stehen.
2. jeweils einer Prüfungsordnung für den Bachelor- und Masterstudiengang. Diverse technische und administrative Details, die bei allen Prüfungsordnungen des Departments gleichartig gehandhabt werden, werden im Department Elektrotechnik und Informatik in einem separaten, zentralen Dokument festgelegt, den sog. „Einheitliche Regelungen für Prüfungen in den Studiengängen des Departments Elektrotechnik und Informatik der Fakultät IV an der Universität Siegen". Dieses Dokument ist daher ebenfalls Teil der Akkreditierungsunterlagen.
3. diesem Modulhandbuch, das ECTS-konforme Beschreibungen der Module (Prüfungsfächer bzw. Lehrveranstaltungen)für den Masterstudiengang Mechatronics enthält.

1.2 Struktur und Lesehinweise zu den Modulbeschreibungen

Die Modulbeschreibungen beinhalten alle Merkmale, die gemäß den ECTS- bzw. ASIIN-Richtlinien anzugeben sind. Die Bedeutung der Merkmale sollte i.d.R. offensichtlich sein. Die hier abgedruckten Modulbeschreibungen werden automatisch aus umfassenderen Datenbeständen generiert, auf die sich auch Funktionen aus anderen Bereichen abstützen, u.a. studiengangsübergreifende Informationen zu Lehrveranstaltungen, departmentweite Veranstaltungsplanung, Auslastungsberechnungen u.a. Aus diesem Grund sind die Angaben in Einzelfällen detaillierter als erforderlich.

1.2.1 Angaben in „Angebote in den Semestern"

Im Masterstudiengang Mechatonics werden Pflichtveranstaltungen generell einmal jährlich angeboten. Die Anordnung in Sommer- oder Wintersemester ist im Allgemeinen fest. Wahlpflichtveranstaltungen werden ebenfalls einmal jährlich angeboten.

1.2.2 Angaben in „Prüfungsform / Bedingungen für Schein"

Angegeben ist hier, die Prüfungsform im jeweiligen Studiengang sowie weitere Detailangaben, speziell bei Praktika, Seminaren und sonstigen Studienleistungen, deren Erbringung durch einen Schein bestätigt wird.
Für die Prüfungsform werden folgende Abkürzungen verwendet:

- K1 Klausur 60 Minuten
- K2 Klausur 120 Minuten
- K3 Klausur 180 Minuten

- M Mündliche Prüfung (20-40 Min.)
- P Praktikum
- S Seminar

Diese Abkürzungen werden auch in allen neueren Prüfungsordnungen des Departments verwendet. Gemäß den einheitlichen Regelungen für Prüfungsordnungen des Departments können Klausuren von 120 bzw. 180 Minuten verteilt durchgeführt werden, und zwar bei 120 Minuten an zwei Terminen zu je 75 Minuten und bei 180 Minuten an vier Terminen zu je 60 Minuten. Die Entscheidung liegt im Ermessen des Veranstalters.

Da alle Lehrveranstaltungen im Masterstudiengang Mechatronics in englischer Sprache durchgeführt werden, sind die nachfolgenden Modulbeschreibungen ebenfalls in Englisch.

2. Modulbeschreibungen

2.1 Embedded Control (EC)

Classification in curriculum:	AnpM
Teaching format:	Lecture: 2 SWS; exercises/laboratory: 2 SWS
Workload:	150 h (Presence: 60 h, self study: 45 h, exam preparation: 45 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr. R. Obermaisser
Lecturer:	Prof. Dr. R. Obermaisser
Semester:	First / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Fundamentals of Control Theory, Electronics, Basic Digital Electronics, Programming Languages, Modeling and Simulation

Types of media:

Powerpoint

Targeted learning outcomes:

The purposes of the course are to

- become acquainted with application fields of embedded control systems
- understand working methods to develop embedded control systems
- understand models of embedded control systems and comprehend the interplay of software and hardware with the physical environment
- get to know motivations of Rapid Control Prototyping (RCP)
- work with state-of-the-art development tools for real-time simulation and rapid control prototyping (e.g., MATLAB/Simulink)
- provide background knowledge (numerical mathematics, operating systems, system theory) to understand the functionality of these development tools.
- finally bridge the gap from theory to practical implementing by performing a practical experiment in the lab.

Content:

1. Modeling and Mathematical Descriptions of Dynamic Systems
   - Discrete Dynamics
   - Hybrid Systems
   - Composition of State Machines
   - Concurrent Models of Computation
2. Design of Embedded Control Systems

- Embedded Processors
- Memory Architectures
- Input and Output
- Multitasking
- Scheduling

3. Analysis and Verification
   - Invariants and Temporal Logic
   - Equivalence, Refinement, Simulations
   - Reachability Analysis and Model Checking
   - Quantitative Analysis
4. State-of-the-Art Tools for Embedded Controller Development
   - MATLAB/Simulink

Literature:

- E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, LeeSeshia.org, 2011
- Peter Marwedel. Embedded System Design, Embedded Systems Foundations of Cyber-Physical Systems. 2nd Edition. 2011
- L. Gomes, J.M. Fernandes. Behavioral Modeling for Embedded Systems and Technologies: Applications for Design and Implementation. Information Science Reference. 2009
- P.J. Mosterman. Model-Based Design for Embedded Systems. CRC Press. 2010
- J. Ledin. Embedded Control Systems in C/C++: An Introduction for Software Developers Using MATLAB. CMP Books. 2004

2.2 Electrical and Electronic Engineering I (EEEI)

Classification in curriculum:	AnpM
Teaching format:	4 SWS (Mixed Lectures and Exercises)
Workload:	150 h (Presence: 60 h, self study 50 h, exam preparations: 40 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Dr. Teichmann
Lecturer:	Dr. Teichmann
Semester:	First / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Basic knowledge of Electricity, Mathematical Skills including Infinitesimal Calculus, Complex Calculus, Vector Calculus

Types of media:

Methods and Examples are derived at the blackboard, displayed with slides and Simulated with Computer

Targeted learning outcomes:

The students

- are familiar with the physical quantities appearing in electric circuits.
- are able to analyse DC circuits and to choose the appropriate method from a set of methods .
- are familiar with the dynamic behaviour of inductances and capacitances.
- are able to analyse the steady state behaviour of AC circuits using the representation with phasors.
- know the behaviour of polyphase circuits.
- know how to derive differential equations for easy dynamic circuits and to solve for the unknown quantities.
- have the basis to understand advanced tasks and topic taught in following courses, e.g. Electrical and Electronic Engineering II or Actorics.

Content:

Electromagnetic Fields

- Electric Forces and Electric Fields
- Magnetic Forces and Magnetic Fields
- Electrodynamics

Basic Circuit Theory

- Energy and Charge
- Current and Kirchhoff's Current Law
- Voltage and Kirchhoff's Voltage Law

- Energy Flow in Electrical Circuits
- Circuit Elements: Resistances and Sources
- Series and Parallel Resistances: Voltage and Current Dividers

The Analysis of DC Circuits

- Superposition
- Thevenin's and Norton's Equivalent Circuits
- Source Transformations
- Node-Voltage Analysis
- Loop-Current Analysis

The Dynamics of Circuits

- Theory of Inductors and Capacitors
- First-Order Transient Response of RL and RC-Circuits
- RLC Circuits

The Analysis of AC Circuits

- Introduction to Alternating Current (AC)
- AC Circuit Problem
- Representing Sinusoids with Phasors,
- Impedance: Representing the Circuit in the Frequency Domain
- Phasor Diagrams for RL, RC, and RLC-Circuits

Power in AC Circuits

- AC Power and Energy in the Time-Domain
- Power and Energy in the Frequency Domain
- Transformers
- Polyphase Systems

Literature:

- Foundations of electrical engineering - J. R. Cogdell - Prentice Hall
- Introduction to Electrical Engineering - M.S. Sarma - Oxford University Press
- Electric Circuits (5th edition) - Nilsson and Riedel - Addison Wesley
- Schaum's Outline of Basic Electrical Engineering - J.J. Cathey - McGraw-Hill Professional Publishing
- Introduction to Electric Circuits (4th edition) - Dorf & Svoboda, - John Wiley and Sons
- Electric Circuit Analysis - Ken Sander - Addison Wesley
- Basic Engineering Circuit Analysis (5th edition) - J David Irvin - Prentice Hall
- Electrical and Electronic Technology (8th edition) - E. Hughes - Prentice Hall
- Linear Circuit Analysis (2nd Edition) - DeCarlo/Lin - Oxford University Press
- Fundamentals of Electrical Engineering - L.S. Bobrow, - Oxford University Press
- Electrical and electronics engineering for scientists and engineers - K. A. Krishnamurthy, M.R. Raghuveer - John Wiley and Sons

2.3 Materials Science and Engineering (MSE)

Classification in curriculum:	AnpM
Teaching format:	Lecture: 2 SWS, Exercise: 2 SWS
Workload:	150 h (presence: 60 h, self-study: 50 h, exam preparations: 40h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Dr. Staedler
Lecturer:	Dr. Staedler
Semester:	First / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Study/exam deliverables:

paper/presentation

Recommended prerequisites:

Scientific base knowledge (Bachelor level)

Types of media:

Black board, power point, exercises

Targeted learning outcomes:

Scientific component:

The students will have a basic understanding of materials science and engineering. They Students will know about the linear interrelationship between processing, structure, properties, and performance of materials. Additionally, they will have a general understanding of the different materials classes and their associated property spectrum along with the knowledge how to verify these properties (testing methods). Finally, based on this background the students will be able to pick materials suitable for a given application.

Social component:

The students gain the ability to present complex scientific content in a generally understandable form. In addition to that they are required to work in small teams to prepare a joint paper and oral presentation. Finally, the students will learn to solve problems in a fixed time setting.

Content:

The course covers a basic introduction to materials science and engineering including:

- Materials Classifications
- Materials structure: atomic structure, crystalline and amorphous materials
- Imperfections in solids, dislocations and strengthening mechanisms
- Phase diagrams and phase transformations
- Mechanical, electrical, magnetic, and optical materials properties and selected testing methods

- An introduction to processing and characteristics of metals (ferrous and non-ferrous alloys), ceramics, polymers, and composites
- Material selection and design considerations

Literature:

- W.D. Callister, Materials Science and Engineering. An Introduction, Wiley 2003 (library: 85 ZLI 2053)

2.4 Machine Elements (MaEl)

Classification in curriculum:	AnpM
Teaching format:	4 SWS (lecture in winter semester, integrated exercises)
Workload:	150h (presence: 60 h, self study: 50 h, exam preparation: 40 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. Christoph Friedrich
Lecturer:	Prof. Dr.-Ing. Christoph Friedrich
Semester:	First / winter semester
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Mathematical background in Analysis and Algebra, background of basic mechanics, fundamentals of materials in engineering

Types of media:

Powerpoint presentation, sketches on overhead projector, lecture notes, presented exercises

Targeted learning outcomes:

- Factual knowledge: ability of identifying, understanding, working with Machine Elements in Technilcal Design, assessment of Machine Elements considering their risk of failure when exceed¬ing limit load; design approach and criteria, examples for dimen¬sioning.
- Skills of methodolgy: linking together knowledge from Mathe¬matics, Mechanics, Material Science to generate powerful pro¬ducts (integration of knowledge).
- Social skills: working cooperative during team exercises.

Content:

- Introduction
- Fundamentals of Machine Elements (definition of mater¬ial influences and material limits, loading capacity and stress limit, distinguishing single component elements (pins, keys, springs, axles, shafts), multi component elements (bearings, gears, couplings, clutches, chain- and belt drives) as well as joining tech¬niques (bolted joints, welding)
- Welded Joints (extension)
- Screw-Joints (extension)
- Chains and belts (extension)
- Couplings, clutches and Brakes (extension)

This lecture gives a basic overview of the major Machine Elements in the field of today´s Mechanical Engineering. Their functions and their interaction in the machine system will be explained, advantages and disadvantages will be presented. Based on the loading limits (resulting from material strength and geometry) dimensioning methods are proposed.

Literature:

- Lecture notes of C. Friedrich for Machine Elements.
- Hamrock, B.J. et al. Fundamentals of Machine Elements, Boston, Mc Graw Hill Higher Education, 2005, ISBN 0-07-111142-5.
- Richard Budynas: Shigley´s Mechanical Engineering Design. New York, Mc Graw Hill, 2006, ISBN 0073312606.
- Friedrich, C. :Designing Fastening Systems. In: Totten, G.E.; Xie, L.; Funatani, K. (editors): Modeling and Simulation for Material Selection and Mechanical Design. New York, Marcel Dekker, 2004. ISBN 0-8247-4746-1.

2.5 Automation and Industrial Communication (AiC)

Classification in curriculum:	IM
Teaching format:	4 SWS (lecture and exercises, face-to-face and self study)
Workload:	150 h (Presence: 60 h, self study: 45 h, exam preparation: 45 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. Günter Schröder
Lecturer:	Prof. Dr.-Ing. Günter Schröder
Semester:	First / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)
Recommended prerequisites:	none
Types of media:	Powerpoint, Overhead slides, handwritten notes
Targeted learning outcomes:	The students will be able to choose the appropriate software tools for their application. They get familiar with the types of interface signals of industrial automation systems, especially PLCs, which are the standard automation devices in the industry. With the knowledge about how PLCs communicate with their periphery or with each other respectively they can decide about the usability of industrial communication systems.
Content:	First the principles of runtime and application software are explained. The basic properties of the usual programming languages are explained. Then the interfaces to the process and to the other automation devices will be explained. This covers digital and analog signals, A/D- and D/A-conversion, absolute and incremental encoders, field bus systems, and Industrial Ethernet.
Literature:	Günter Schröder: Automation and Industrial Communication Part I, II and III, available at the chair or in Moodle

2.6 Fluid Power (FP)

Classification in curriculum:	IM
Teaching format:	4 SWS
Workload:	150 h (presence: 52 h, self-study and exam preparations: 98 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. Th. Carolus
Lecturer:	Prof. Dr.-Ing. Th. Carolus
Semester:	First / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Basic knowledge of Fluid Mechanics and Thermodynamics

Types of media:

Transparencies, black board, manuscript, experiments

Targeted learning outcomes:

Students achieve an understanding of the basic concepts and components in fluid power technology, i.e. in (oil) hydraulics and pneumatics.
Students are able to work in small teams and produce reports on technical subjects by group lab experiments.

Content:

- Introduction (hydrostatic vs. hydrodynamic principle, fluid power drives - the general idea, applications, fluid power systems in competition with other technologies, brief history, economic importance)
- Basic hydromechanic and thermodynamic concepts (Pascal’s law and its application in cylinders, motors, pumps and transmissions, first law of thermodynamics, equation of continuity, pressure loss, choked nozzle)
- The working fluids (hydraulic oils and fluids, compressed air)
- Hydraulic components (pumps and motors, actuators, valves, accumulators, ancillary devices)
- Pneumatic components (air preparation, valves and sensors, cylinders)
- Circuits
- Laboratory work (hands on experiments)

Literature:

- Th. Carolus: Fluid Power, Lecture Notes University Siegen, 2002
- F. Don Norvelle: Fluid Power Technology, West Publishing Company, 1994

2.7 Fundamentals of Control (FoC)

Part 1: Linear Control (LC)
Part 2: State Space Control (SSC)

Classification in curriculum:	IM
Teaching format:	4 SWS (for each part: Lecture: 1.5 SWS, Exercises: 0.5 SWS)
Workload:	150 h (Part 1: presence: 30 h, self study: 30, exam preparations 15 h Part 2: presence: 30 h, self study: 30, exam preparations 15 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. Robert Mayr
Lecturer:	Prof. Dr.-Ing. Robert Mayr
Semester:	First / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K1 for each part (written exam)

Study/exam deliverables:

Two separate exams are provided in order to adapt examination requirements to the specific contents and learning outcomes of the two module parts.

Recommended prerequisites:

Basic knowledge in Mathematics (especially differential equations) and Physics

Types of media:

Beamer presentation, simulation software

Targeted learning outcomes:

Part 1:
The objective of the course is that the students will be able to understand the dynamical behaviour of control circuits. Thus, they can design and analyse linear control systems in the requency domain. These skills are also necessary prerequisites for upcoming courses in Control, especially in Fundamentals of Control.
Part 2:
The objective of the course is that the students will learn methods for control design directly in the time domain. As high order, multivariable and nonlinear systems are included, the students will be able to design controllers in a very complex environment. The course is theoretically oriented.

Content:

Part 1:
The course covers classical control theory, which is based on the analysis of control circuits in the frequency domain. Properties as stability, freedom of periodic oscillations and freedom of a steady state control deviation even in case of disturbances are explained. Flow diagrams, linear controllers and algebraic as well as graphical stability criteria are included in the lecture.

The topics in detail are:

- Flow diagram and its components;
- Structure of a control circuit;
- Step response;
- Laplace Transformation;
- Characteristic equation of a polynomial;
- Flow diagram algebra;
- Complex s-plane;
- Linear time invariant transfer elements;
- Application of PID-controllers;
- Hurwitz criterion;
- Root locus;
- Nyquist criterion;
- Bode diagram.

In the exercises related examples are presented.

Part 2:

The modern control theory is based on methods, where the system representation is performed in the time domain. Control systems for single input/output systems as well as for multivariable systems are explained. On top of that, also estimators for non measurable variables as well as basic issues for the description of nonlinear systems are presented.

The topics in detail are:

- Description of systems in state space;
- Controllability, observability;
- Eigenvalues, eigenvectors;
- Equivalent system transformation;
- The canonical forms;
- State feedback control;
- Observers;
- Decoupling of multivariable systems;
- Nonlinear systems in state space;
- Feedback linearization.

In the exercises related examples are presented.

Literature:

Part 1 and Part 2:

- Gene F. Franklin, J. David Powell, Abbas Emami-Naeini: Feedback Control of Dynamic Systems, Prentice Hall, 2005, 5th edition; ISBN: 0131499300

2.8 Project Management (PM)

Part 1: Methods and Instruments

Part 2: International Engineering and Construction Projects

Classification in curriculum:	IM
Teaching format:	4 SWS (for each part: lecture including exercises)
Workload:	150 h (**Presence: 60 h, self studies: 45 h, exam preparation: 45 h**)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-techn. Gerald Adlbrecht
Lecturer:	Prof. Dr.-techn. Gerald Adlbrecht
Semester:	Part 1: First / winter semester / yearly
	Part 2: Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K1 for each part (written exam)

Study/exam deliverables:

Two separate exams are provided in order to adapt examination requirements to the specific contents and learning outcomes of the two module parts.

Recommended prerequisites:

none

Types of media:

Data Projector, Black Board, Flip Chart, Group Work, Presentation

Targeted learning outcomes:

Part 1 of the course focuses on the set of modern methods and instruments to plan and control the process of innovation and investment projects.

The objective of this basic course is to prepare students for their future managerial tasks as project team member, project coordinator, or project controller.

Upon completion of the course, students should have the knowledge to prepare the project kick-off, should be able to structure projects, to plan, and control projects in terms of time, cost, and quality throughout all project stages from initialisation to handing over. General competencies addressed are: professional English language skills, to chose and apply suitable methods for new and unfamiliar tasks, systemic (holistic) thinking, complexity reduction by structuring and modeling, master interdisciplinary working environment.

Part 2 of the course focuses on the application of project management in its most extensive field: Machinery and plant engineering and construction.

The objective of this basic course is to examine the management tasks from a contractor's point of view from prequalification to handing over of the plant or machinery to prepare students for their future managerial tasks as project team member, project coordinator, or project manager.

Upon completion of the course, students should have the knowledge about the most important specific processes throughout the project. to prepare bids, organise financial engineering, set up procurement, contract, risk, and claim management. General competencies addressed are: professional English language skills, systemic (holistic) thinking, interdisciplinary problem solving under constraints of incomplete information.

Content:

Part 1 of the course contains class lectures and group work and starts with theoretical considerations of systems theory and heuristics. After investigating the relevant aspects of project initiation, all major methods and tools of project planning and project control and the assistance of computers in project management is explained.

- Heuristics and Systems' Theory
- Project Definition and Goal Setting
- Project Structuring, Scheduling and Resource Planning
- Project Control and Monitoring Project Progress
- Computer Basics for Project Work
- Project Management Systems

Part 2 of the course contains class lectures and group work and starts with engineering business and its organisational background. After investigating the relevant aspects of project tendering, all major managerial aspects are dealt with.

- Special issues of engineering and construction business
- Prequalification and tendering
- Macro-organisation, contracting, and subcontracting
- Risk management and financial engineering
- Procurement and logistics
- Introduction to contract law and claim management

Literature:

Part 1:

- Turner, J.R., Simister, S.: Gower Handbook of Project Management; ISBN 0 566 08138 5, Gower Publishing Ltd., England
- Lock, D.: Project Management, Seventh Edition, ISBN 0 566 08225 X, Gower Publishing Ltd., England.
- Milosevic, D.Z.: Project Management Tool Box. Wiley&Sons, ISBN 0-471-20822-1

Part 2:

- Turner, J.R.: Commercial Project Manager ISBN 0-07-707946-9, McGraw-Hill, 1995
- Austen, A.D., Neale, R.H.: Managing Construction Projects, ILO Geneva
- PMI PMBok 2008

2.9 Electrical Machines and Power Electronics (EMPE)

Classification in curriculum:	AnpM
Teaching format:	Lecture: 2 SWS / Exercises + Simulation Lab: 2 SWS
Workload:	150 h (presence: 60 h, self-study and homework: 40 h, exam preparation: 50 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. M. Pacas
Lecturer:	Prof. Dr.-Ing. M. Pacas
Semester:	Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Basic Knowledge of Electrical Engineering Bachelor-Level or Course Electrical and Electronic Engineering in Mechatronics Program.

Types of media:

Board, Power Point Presentations,

Targeted learning outcomes:

This course builds the fundament for the course „Actorics“ and introduces the most important chapters of electrical machines and power electronics. The student get acquainted with the steady state behavior of electrical machines in industrial and mechatronic applications and with the power electronics circuits used in the control of machines and in switched power supplies.
After this course the students have the background for the understanding of drives and actuators that include electrical machines and power electronics.
The students acquire the basics skills for the calculation of the steady state behavior of converters and machines and their simulation.

Content:

Power Electronics

- Overview of power semiconductors switches
- DC-DC converters
- Power supplies
- DC-AC converters
- Line frequency AC-DC converters

Electrical Machines

- DC machines
- Induction machines
- PM-Synchronous machines

Exercises and simulation sessions are part of this course.

Literature:

- A.E. Fitzgerald ; Electric Machinery, McGraw Hill Higher Education, 2002, ISBN: 0071230106
- Mohan, N; Undeland, T; Robbins, W: Power electronics, Converters, Applications and Design, John Wiley & Sons, Inc,
- Syed A. Nasar: Schaum's Outline of Electric Machines and Electromechanics (Schaum's Outlines). Mcgraw-Hill. ISBN: 0070458863 Edition 1998
- Rashid, Muhammad H.: Power electronics : circuits, devices, and applications, Englewood Cliffs, N.J. : Prentice-Hall
- El-Hawary, M. E.: Principles of electric machines with power electronic applications, Englewood Cliffs, NJ : Prentice Hall

2.10 Fundamentals for Mechatronic Applications (FMA)

Part 1: Electrical and Electronic Engineering II

Part 2: Mechatronic Design for Production Machines

Classification in curriculum:	VM
Teaching format:	4 SWS (2 h per week mixed lectures and exercises for each part)
Workload:	150 h (Part 1: 75 h: presence 30 h, self-study 25 h, exam preparations 20 h Part 2: 75 h: presence 30 h, self-study, preparations and review 45 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Dr. Teichmann
Lecturer:	Part 1: Dr. Teichmann Part 2: Samih Dahbour
Semester:	Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	Part 1: K1 (Written exam), Part 2: P (practical course (Studienpraktikum) with grade according to § 29 of the Standard Exam Regulations)

Study/exam deliverables:

Two separate exams are provided in order to adapt examination requirements to the specific contents and learning outcomes of the two module parts.

Recommended prerequisites:

Part 1: Topics dealt with in Electrical and Electronic Engineering I are required.

Part 2: None.

Types of media:

Part 1: Methods and Examples are derived at the blackboard, displayed with slides and simulated by computer.

Targeted learning outcomes:

Part 1:

The students

- are familiar with the behavior of semi conductive materials .
- are able to analyze nonlinear circuits containing diodes .
- know the behavior of circuits with transistor and can analyze it.
- can distinguish the biasing from the small signal behavior.
- can use transistor circuits for switching and for amplification purposes.
- are familiar with filter circuits based on operational amplifiers.
- have a basis to understand following modules e.g. Electrical Machines and Power Electronics

Part 2:
To give students the opportunity to use the mechatronics in the industry and implement it in practice.

Content:

Part 1:

Semiconductor Diodes

- Circuit Analysis for an Ideal Diode
- The pn-Junction Diode
- Equivalent Circuits for Nonideal Diodes

Semiconductor Transistors

- Bipolar-Junction-Transistor (BJT)
- Junction Field-Effect Transistors
- Metal-Oxide Semiconductor Field-Effect-Transistors (MOSFETs)

Semiconductor Circuits

- Transistor Amplifier-Switch Circuit Analysis
- Transistor Applications
- Small-Signal Amplifiers

Analog Electronics

- Electrical Filters
- Feedback Concepts
- Transistor Circuits
- Operational-Amplifier Circuits
- Basic Op-Amp Amplifiers
- Linear Op-Amp Circuits
- Nonlinear Op-Amp Circuits
- Instrumentation Amplifiers
- Analog Active Filters

Part 2:

1. Introduction

- Review of history in the design and construction of production machines
- Definition of Mechatronics in the industry of production machines
- Technical systems in general
- Basic structure of a mechatronic system
- Embedding of mechatronic systems in higher layers of automation
- Different types of production machines
- Typical bloc-diagram of a modern production machine
- Presentation of a “Flat Metal Processing Line” as example

2. Project Management

2.1 Definition

- Specification
- Standards and directives

2.2 Basic Engineering and Performance calculation

- Process data, performance and production curve

- Accuracy, resolution, tolerance and real-time control constraints

2.3 Interaction between mechanics and electronics: Mechatronics

- Engineering of drives, gear boxes, clutches, couplings and brakes

(Details of Drives and Power-Electronics see lecture Prof. Pacas)

- Engineering of digital and analogue sensors

2.4 Example: “Flat Metal Processing Line”

- Different versions for different production purposes
- Maximum extension for fully automatic production
- Different types of cross cutting shears

3. Hydraulics, Pneumatics
(Details see lecture Prof. Carolus)
Basic considerations for hydraulics and pneumatics for the performance

4. Cooling

- Cooling systems
- Ventilators and blowers
- Air-conditioners
- Engineering and influence on the performance
- Interface to automation
- Example: “Flat Metal Processing Line”

5. Communication
(Details see lecture Prof. Schroeder)

- WAN, LAN, Field-busses
- Horizontal and vertical integration
- Considerations for Engineering
- Example: “Flat Metal Processing Line”

6. Cabinets and Wiring

- Standards and directives
- Engineering
- Power- and signal cable trays
- Grounding and shielding
- Example: “Flat Metal Processing Line”

7. Documentation

- Standards
- Safety aspects
- Language
- Example: “Flat Metal Processing Line”

8. Commissioning, startup, customer acceptance

- Planning for commissioning
- Consideration for availability
- Spare parts
- Maintenance
- After sales service
- Example: “Flat Metal Processing Line”

9. Commercial and legal considerations
   - Calculation (pre- and post-)
   - Risks
   - Sales order confirmation
   - Terms and conditions
   - Warrantee
   - Example: “Flat Metal Processing Line”

Literature:

Part 1:

- Foundations of electrical engineering - J. R. Cogdell - Prentice Hall
- Introduction to Electrical Engineering - M.S. Sarma - Oxford University Press
- Electric Circuits (5th edition) - Nilsson and Riedel - Addison Wesley
- Schaum's Outline of Basic Electrical Engineering - J.J. Cathey - McGraw-Hill Professional Publishing
- Introduction to Electric Circuits (4th edition) - Dorf & Svoboda, - John Wiley and Sons
- Electric Circuit Analysis - Ken Sander - Addison Wesley
- Basic Engineering Circuit Analysis (5th edition) - J David Irvin - Prentice Hall
- Electrical and Electronic Technology (8th edition) - E. Hughes - Prentice Hall
- Linear Circuit Analysis (2nd Edition) - DeCarlo/Lin - Oxford University Press
- Fundamentals of Electrical Engineering - L.S. Bobrow, - Oxford University Press
- Electrical and electronics engineering for scientists and engineers - K. A. Krishnamurthy, M.R. Raghuveer - John Wiley and Sons

Part 2:

- Will be published during the lecture

2.11 Engineering Design (ED)

Part 1: Design Methodology

Part 2: Techno Economic Design

Classification in curriculum:	AnpM
Teaching format:	4 SWS (2 h per week mixed lectures and exercises for each part)
Workload:	150 h (2*75 h) Presence: face to face teaching 2*12 h, face to face exercises 2*12 h Independent self study: 2*27 h Exam preparations: 2*24 h
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr. Lohe
Lecturer:	Prof. Dr. Lohe
Semester:	Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam, 1h for each part)

Recommended prerequisites:

none

Types of media:

Beamer, Overhead, Blackboard, Exercises

Targeted learning outcomes:

Part 1:

It is the aim of this course to teach the students the basics of Design Methodologies in order to encourage them towards a systematic approach to new industrial design projects.

The learning outcomes are to develop

- awareness for basic rules in design projects
- apprehension of the systematic approach to design work
- knowledge of advantages and disadvantages of teamwork
- basic ability to coordinate and moderate teams
- apprehension of differences and common features of different design methodologies
- ability to apply the Value Analysis work plan to complex systems and problems

Part 2:

The learning outcomes are to develop

- handling of costs in order to technical requirements
- knowledge of advantages and disadvantages of standardization
- awareness for basic rules of calculation systems in companies
- commitment of different production methods according to costs
- knowledge of cost structures
- awareness for basic rules of calculation systems in companies

Content:

Part 1:

A summary of the content is

Terms and definitions

- Functions
- Assignment of functions
- Function structure
- Function carriers
- Function costs
- Value
- Value analysis
- Other design methodologies

The Management of a design project

- Value analysis work plan
- How to prepare a project
- How to analyse and describe the current situation
- How to describe the target situation
- How to apply idea-finding techniques
- How to develop and evaluate solutions and prepare decisions
- How to put the selected solution into practice

Part 2:

A summary of the content is

- Cost carriers
- Department costs
- Advantageous design examples
- Function costs
- Part series
- Product series
- Part series systems
- Dimensioning theory
- Cost prediction

Literature:

Part 1:

- Lohe, R.: Engineering Design 1 (ED I), Lecture Notes; University of Siegen 2012

Part 2:

- Lohe, R.: Engineering Design 1 (ED II), Lecture Notes; University of Siegen 2011

2.12 Introduction to Programming (IP)

Classification in curriculum:	IM
Teaching format:	4 SWS (lecture: 2 hours/week; lab: 2 hours/week)
Workload:	150 h (presence: 60 h, self study: 70 h, exam preparation: 20 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr. Roland Wismüller
Lecturer:	Prof. Dr. Roland Wismüller
Semester:	Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	P (Practical course (Studienpraktikum) with grade according to § 29 of the Standard Exam Regulations)

Recommended prerequisites:

Basic knowledge of computers and computer science

Types of media:

video projector, blackboard

Targeted learning outcomes:

The students

- know the foundations of imperative programming in the programming language C++, including the most important language constructs of C++.
- can analyse informal algorithmic descriptions and can apply the proper language constructs to implement them.
- have the practical ability to create simple programs in a self-employed and correct way, using adequate programming tools (compiler, make, debugger).
- understand the basic concepts of object oriented programming.
- can apply object oriented techniques to model simple real world scenarios.
- can analyse unknown program code in order to determine and understand its behaviour.

Content:

The course introduces the basic concepts of computer programming, with emphasis on the requirements of engineering students. It deals with sequential, imperative and object-oriented programming, using the C++ programming language. The lecture is accompanied by a series of programming assignments.

Detailed contents of the lecture:

- Introduction: algorithms and programs
- Data: variables, types and constants
- Statements: expressions, conditional statements, loops
- Exception handling
- Functions and recursion

- Data structures: arrays and structures
- Pointers, references, memory allocation
- Classes: attributes, methods, constructors, destructors, operators
- Object oriented programming: inheritance, polymorphism, abstract classes
- Container classes, standard template library

Literature:

- J. Liberty. Teach Yourself C++ in 10 Minutes. Sams Publishing, 2002.
- Bruce Eckel: Thinking in C++, Vol. 1, 2nd Edition< Prentice Hall, 2000.

2.13 Advanced Control (AC)

Part 1: Digital control
Part 2: Control Laboratory

Classification in curriculum:	VM
Teaching format:	4 SWS (Lecture: 2 SWS, exercises and lab : 2 SWS)
Workload:	150 h (Presence: 60 h (30 lecture, 30 laboratory), self studies: 50 h, exam preparation: 40 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. Hubert Roth
Lecturer:	Part 1: Prof. Dr.-Ing. Hubert Roth Part 2: Prof. Dr.-Ing. Hubert Roth, Prof. Dr.-Ing. Robert Mayr
Semester:	Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	Part 1: K1 (Written exam), Part 2: P (practical course (Studienpraktikum) with grade according to § 29 of the Standard Exam Regulations)

Recommended prerequisites:

Part 1: Not applicable
Part 2: Basic Control, State Space Control, Digital control

Types of media:

Part 1: Powerpoint and blackboard, Part 2: None

Targeted learning outcomes:

Part 1:
The purposes of this course are to get used to the z-transformation and the applications in digital control systems. Students will become acquainted with the use of z-transferfunctions in the control loop and the design of digital controllers.

Part 2:
The purposes of the laboratory are to realize and understand the control structures given in the lectures. The theory given in the lectures "Basic Control", "State Space Control", and "Digital Control" are demonstrated at real hardware experiments. The students will learn to install control algorithms to real systems and to test closed loop dynamics. They will learn the fundamentals of MATLAB for the simulation of real systems.

Content:

Part 1:

- Description of digital control systems with z-transformation
- z-transfer-functions in the control loop
- Design of different types of digital controllers
- Basics of optimal control systems

- Design of controllers in state space

Part 2:

The laboratory contains five of the following experiments:

- Basics of MATLAB/Simulink
- Decoupling of control systems
- State space controller in MATLAB
- Simulation of continuous and digital PID-controllers
- Position Control with a PV- and a Dead-Beat Controller

Literature:

Part 1:

- Gene F. Franklin; J. David Powell, Michael L. Workman: “Digital control of dynamic systems”.
- Isermann, Rolf: “Regel- und Steueralgorithmen für die digitale Regelung mit Prozessrechnern”.
- Brian D. O. Anderson; John B. Moore: “Optimal control: linear quadratic methods”.
- Föllinger, Otto: “Optimale Regelung und Steuerung”.
- Föllinger, Otto: Lineare Abtastsysteme“.
- Wolfgang Latzel: “Einführung in die digitalen Regelungen”.
- Hung V. Vu; Ramin S. Esfandiari: “Dynamic Systems“
- Martin Horn; Nicolas Dourdoumas: “Regelungstechnik”
- Richard C. Dorf; Robert H. Bishop: „Modern Control Systems“
- J. Lunze: “Regelungstechnik 2, Mehrgrößensysteme, Digitale Regelung“
- Holger Lutz; Wolfgang Wendt: „Taschenbuch der Regelungstechnik“

Part 2:

- Laboratory experiment descriptions in moodle https://moodle.uni-siegen.de/
- Guideline for laboratories in moodle https://moodle.uni-siegen.de/
- Experiment descriptions on the venture page http://www.quanser.com
- J. Schwarzenbach, K.F. Gill, System Modelling and Control, Arnold, 1984
- J. Lunze, Regelungstechnik 2, Springer Verlag, 2002
- R. Isermann, Digitale Regelsysteme, Springer Verlag, 1987
- O. Föllinger, M.Kluwe, Laplace-, Fourier- und z-Transformation , Hüthig, 2009
- H. Unbehauen, Zustandsregelungen, digitale und nichtlineare Regelsysteme , Friedr. Vieweg & Sohn Verlag, 2007

2.14 Machine Dynamics and System Dynamics (MD/SD)

Classification in curriculum:	VM
Teaching format:	4 SWS (Lecture: 2 SWS, exercise: 2 SWS)
Workload:	150 h (presence: 60 h, self-study: 50 h, exam preparations: 40 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr. Fritzen
Lecturer:	Prof. Dr. Fritzen
Semester:	Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written eaxm)

Recommended prerequisites:

Basic knowledge in Engineering Mechanics, Mathematics and Physics for Engineers as taught in B.Sc./B.Eng. Courses

Types of media:

Blackboard, Projector/Beamer, Demonstrations (computer, simple experiments), manuscript for download available, solutions of homework problems available

Targeted learning outcomes:

Basic question: Which learning outcomes should be attained by students in the module?
Technical knowledge:
Based upon engineering mechanics and related mathematical courses (Bachelor level), the students get an overview on typical problems of machine dynamics. Their knowledge is expanded with respect to the possibilities and methods of mechanical-mathematical modeling including solution methods which they can apply to solve dynamical problems. The link to state space concepts expands their view to a more general system oriented approach including control of mechanical systems.
Technical Skills:
The methodological approach is in the foreground, not single applications. The students learn how to use a method by reduction of the problem to the most essential effects and how to transfer their knowledge of a method to a wider range of applications. They learn how to classify a dynamical problem and derive a solution.
Furthermore, in homework units the students learn to solve dynamic problems efficiently with computers using MATLAB programming. Solutions will be scrutinized critically with respect to their plausibility. They are trained to be able to check their results and to recognize the bounds of applicability of the models used. Examples and exercises from robotics, vehicle dynamics or rotating systems will illustrate the mathematical description and consolidate the methods learned.
Social Skills:

Students will train their ability to formulate a problem in an engineering context. They learn to solve problems in limited time and how to express themselves clearly to describe their solution appoach in an understandable manner during the exercises.
Techn. Knowledge: 40%, Techn. Skills: 45 %, Social Skills: 5 %

Content:

The description should indicate the weighting and level of the content.
Introduction (5%): Problems of machine dynamics, physical and mathematical modeling.
Kinematics (30%): Kinematic description of rigid bodies and multibody systems, inertial and body-fixed coordinate systems, constraints, rotation matrices, relative motion.
Kinetics (35%): momentum and angular momentum theorem for rigid 3D systems, Euler's equations, Lagrange-eqns. for conservative and non-conservative systems, linearization, state space description of mechanical systems, numerical solution, dynamics of rigid machines and mechanisms.
Vibrations of machines (30%): Phenomena and sources for vibrations, free and forced vibrations of mechanical systems with one and multi degrees of freedom, vibration isolation and absorber, torsional vibrations in drive trains, vibration of vehicles, simple active vibration control.

Literature:

- Fritzen, C.-P., „Machine and System Dynamics“, Lecture Notes, Univ. of Siegen, 2004.
- Ginsberg, J.H., “Advanced Engineering Dynamics”, 2nd edition, Cambridge Univ. Press, 1998
- Moon, F.C., “Applied Dynamics: With Applications to Multibody and Mechatronic Systems”, John Wiley & Sons, 1998
- Inman, D.J., “Engineering Vibrations”, Prentice Hall, 1994
- Ginsberg, J.H., “Mechanical and Structural Vibrations- Theory and Applications”, John Wiley, 2001

2.15 Sensorics (SEN)

Classification in curriculum:	IM
Teaching format:	4 SWS (Lecture: 2 SWS, Exercises: 2 SWS)
Workload:	150 h (presence: 60 h, self study: 60 h, exam preparations: 30 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. Oliver Nelles
Lecturer:	Prof. Dr.-Ing. Oliver Nelles
Semester:	Second / summer semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Basic knowledge in Mechanics, Physics, Mathematics and Electrical Engineering

Types of media:

Lecture: lecture notes, CD, Notebook, Beamer
Exercises: work sheets, supplements, written form
Practices: models for applications and demonstrations of sensor operations

Targeted learning outcomes:

Two main parts: A) Physical principles required for measuring the most important quantities. Error propagation. B) Basics in signal processing: FFT, digital dynamic systems, filters.

Content:

A: Measurement Techniques

- Introduction to Measurement Techniques
- Measurement of Electrical Quantities
- Measurement of Non-Electrical Quantities
- Digital Measurement Techniques
- Measurement Errors and Statistics
- Static and Dynamic Behavior of Sensors

B: Signal Processing

- Introduction to Signal Processing
- Time-Discrete Systems and Signals
- Transformation Into the Frequency Domain (Discrete Fourier Transform)
- Filters

Literature:

- Sayer M.,Mansingh A.: "Measurment, Instrumentation and Experiment Design in Physics and Engineering", Prentice-Hall, 2004.
- Tumanski S.: "Principles of Electrical Measurement", Taylor & Francis, 2006.

- Oppenheim A.V., Schafer R.W., Buck J.R.: "Discrete-Time Signal Processing", Prentice-Hall, 9. Ed., 2008, 950 p.
- Ifeachor E., Jervis B.: "Digital Signal Processing: A Practical Approach", Prentice-Hall, 8. Ed., 2001, 960 p.

2.16 Actorics (ACT)

Classification in curriculum:	IM
Teaching format:	4 SWS (Lecture: 2 SWS / Exercises + Simulation Lab: 2 SWS)
Workload:	150 h (presence: 60 h, self-study and homework: 40 h, exam preparation: 50 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. M. Pacas
Lecturer:	Prof. Dr.-Ing. M. Pacas
Semester:	Third / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Electrical Machines and Power Electronics
Basic knowledge of Control

Types of media:

Board, Power Point Presentations

Targeted learning outcomes:

The course is based on the fundaments obtained in "Power Electronics and Electrical Machines" and introduces the theory and practical aspects of the most important electrical actuators, mainly electrical drives, used in industrial and mechatronics applications.
The students get acquainted with the function and especially with the dynamic behavior of these devices. The torque, speed and position control of electrical drives and the implementation of the control schemes with appropriate electronics is in the main focus of the course.
The students develop the skills required for the basic design of positioning control loops in mechatronic systems.

Content:

- Mechanics
- Fundamentals of electrical actuators
- Types of machines and characteristics
- Main issues in the design of electromechanical systems
- Current sensors
- Angular and length sensor
- Current control
- Speed control
- Position control
- Torque control in DC-Machines and AC-Machines
- Field orientation

Exercises and laboratory sessions are part of this course.

Literature:

- Mohan, N; Undeland, T; Robbins, W: Power electronics, Converters, Applications and Design, John Wiley & Sons, Inc,
- Leonhard, W.:Control of electrical drives, Springer
- Groß, H. ; Hamman, J. ; Wiegärtner, G. : Electrical Feed Drives in Automation, Publicis MCD Corporate Publishing

2.17 Modeling and Simulation (MS)

Classification in curriculum:	IM
Teaching format:	4 SWS (Lecture : 3 SWS ; exercises : 1 SWS)
Workload:	150 h (presence: 60 h, self-study: 40 h, exam preparation: 50 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Dr. Uwe Lautenschlager
Lecturer:	Dr. Uwe Lautenschlager
Semester:	Third / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Mathematical background in linear algebra and analysis

Types of media:

Power Point Presentation; Exercises, Computer Lab

Targeted learning outcomes:

In engineering science, simulation means the representation of a system (natural or technical) on a digital computer. Especially, for mechatronic systems the aim of simulation is to obtain a deeper understanding of the system behaviour, to accelerate the product development cycle, to efficiently develop controllers, and to optimize existing and future systems. Mechatronics is a challenging application field of simulation methods and various simulation tools for multibody systems, electrical circuits, hydraulic components, or control systems are already commercially available. However, the proper use of such tools requires some basic knowledge about mathematical modeling, simulation methodology, numerical algorithms, and statistical data evaluation. A deeper understanding and qualified usage of these methods and capabilities are the major aims of the simulation courses.

Content:

The lectures on „Modeling and Simulation 1&2", which are part of the mechatronics master course, are given in two successive half semesters during fall and winter. Each course integrates lectures, demonstrations, exercises and computer exercises.
„Modeling and Simulation 1" is concerned with a basic understanding of simulation methods. The general course of a simulation study includes problem specification, mathematical modeling, simulator implementation, model validation, problem solution, and presentation of results. It is discussed with a simple representative example. Some typical simulation tools for different scientific disciplines (mechanical multibody systems, electrical circuits, control engineering) are roughly introduced. One focus is placed on methods for numerical integration of time continuous systems which are described by ordinary differential equations or time dependent equation systems. Working with the corresponding simulation tools requires a

more detailed understanding of the involved numerical algorithms. Special exercises are given for MATLAB and SIMULINK.
„Modeling and Simulation 2“ deals with stochastic simulation and the use of random number generators for the simulation of stochastic influences on dynamic systems. For this purpose, some basics from probability theory and statistics are required and introduced. The simulation of discrete event systems is discussed, which is of great importance for automation systems, digital circuits or manufacturing.
One focus in this part of the lecture is the simulation of spatial systems described by Partial Differential Equations. Examples from structural, thermal, light and EMC simulation are given with details on structural and thermal modeling. This is of great importance for mechatronics students to better understand the interdisciplinary character of complex systems. Additional topics are provided optionally. Topics between both parts of Modeling and Simulation 1 & 2 might be switched.
Summary:

- Application domains of simulation
- Course of a simulation study
- Typical time continuous simulation tools
- Numerical solution of Ordinary Differential Equations
- MATLAB and SIMULINK exercises
- Introduction to probability theory and statistics
- Basic concepts of stochastic simulation
- Discrete event simulation
- Partial Differential Equations
- Modeling and simulation examples from various disciplines

Literature:

- Power point presentations of all lectures (in English language). Link to lecture will be provided in class
- MATLAB&SIMULINK examples presented in the lectures
- Simulation Modeling & Analysis, 4th Edition; Averill M. Law; McGraw-Hill, 2007
- Continuous System Modeling; Francois E. Cellier, Springer Verlag, 1991
- Continuous System Simulation; Francois E. Cellier, Ernesto Kofman, Springer Verlag, 2006

2.18 Software Engineering (SWE)

Classification in curriculum:	VM
Teaching format:	4 SWS (Lecture: 2 SWS / Exercises: 2 SWS)
Workload:	150 h (presence: 60 h, self-study: 70 h, exam preparation: 20 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.–Ing. Madjid Fathi Torbaghan
Lecturer:	Prof. Dr.–Ing. Madjid Fathi Torbaghan
Semester:	Third / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Study/exam deliverables:

Practical coursework with grade for project group (exercise)

Recommended prerequisites:

Programming skills in an Object Oriented Programming language such as C++ or Java/ Knowledge on basic principles of Project Management

Types of media:

Power Point Presentation, Exercises

Targeted learning outcomes:

The learning outcomes are classified based on integration of programming- and project management skills of students towards development of a software prototype. The students have notice (1) to intensify programming experience gained in the course of Introduction to Programming, (2) to learn basic techniques for managing a software development project using software development lifecycle models such as Waterfall Model, Spiral Model, etc. , (3) to be able to develop documents of the early software development phases notably data-, control- and design models using the Unified Modelling Language (UML) editors, (4) to practice development of software Database using ADOX or SQLite library, (5) to develop software Graphical User Interface (GUI), (6) to create project reports based on the project achievements and results, and (7) to practice presentation and demonstration of teamwork results in front of audience using presentation tools such as PowerPoint.

Content:

The goal of this course is to learn and practice “Software Project Management” , and also to improve the teamwork skills of students through a project work. The course consists of lectures and exercise (certain project work) containing oral presentation and written report. In this course an introduction to Software Project Management area are provided so that a student can guide a team and run successful software project. During the lectures, students learn lessons on (1) Software development lifecycles, (2) Software project planning and management, (3) Software requirements engineering, (4) Software modelling and design (based on concepts of Object Oriented Design & Programming) using UML, and (5) Software testing and quality management. In the exercise part which consists of project groups (each includes maximum 5 students), the students practice the lessons based on the defined structure including clear milestones e.g. Software planning milestone which includes development of Work Breakdown Structure, project scheduling, defining resources, establish means of communications between group members, etc. Each group has a project manager who is leading the team. Group members should meet at least once a week and work together on the project. They should create Minutes of Meeting as a protocol and send it to the project tutor. In each milestones, all groups meet the tutor and present their findings, accordingly they discuss project progress with the tutor. At the end of the project, each group presents its outcome in a 30-minutes presentation in front of audience. Also each group submits its developed prototype and project report. The software prototype is mainly to facilitate a kind of engineering and practice-oriented needs (based on mechatronics fields of application).

Literature:

- Agile Project Management, J. Highsmith, 2nd Ed., Addison-Wesley, 2010.
- Applied Software Project Management, A. Stellman & J. Greene, O’REILLY, 2005.
- Software Project Management: A Unified Framework, W. Royce, Addison-Wesley, 1998.

2.19 Mechatronic Systems (MeSy)

Classification in curriculum:	VM
Teaching format:	4 SWS (Lecture: 2 SWS, Exercises / Lab: 2 SWS)
Workload:	150 h (Presence: 60 h (30 lecture, 30 laboratory), self studies: 45 h, exam preparation: 45 h)
Credit Points:	5
Module Level:	Master
Module Coordinator:	Prof. Dr.-Ing. Hubert Roth
Lecturer:	Prof. Dr.-Ing. Hubert Roth
Semester:	Third / winter semester / yearly
Language:	English
Mandatory requirements:	none
Type of exam:	K2 (Written exam)

Recommended prerequisites:

Not applicable

Types of media:

Board, Power Point Presentations

Targeted learning outcomes:

The course “Mechatronics Systems” completes the studies by enhancing and deeping aspects of automatic control engineering, modelling and project management. Main topics are modelling, linearization, discretization, order reduction techniques and system identification. The course also includes a group project for practical application of mechatronic knowledge. Purposes of the course are to

- Design and analyse mechatronic systems as an optimal combination of mechanical, electrical and software components
- Demonstrate the advantage of mechatronic systems in different application areas
- Get experience with mechatronic systems by performing different laboratory experiments
- Apply project management skills with respect to
- Rhetoric
- Risk management and financial planning
- Project structuring, scheduling and resource planning
- Project control and monitoring

Content:

Characteristics of mechatronic systems

- Sensors and actuators for mechatronic systems
- Modelling
- Identification
- Control concepts for mechatronic systems
- Typical examples of integrated mechanical – electrical systems

- Project management skills

Literature:

- R. Isermann: Mechatronische Systeme, Springer Verlag, 1999.
- Schilling: Fundamentals of Robotics, Prentice Hall.
- Craig: Robotics, Addison Wesley.
- Ljung: System Identification, Prentice Hall, 1987, ISBN 0-13-881640-9.
- W. Bolton: Bausteine mechatronischer Systeme, 3. Auflage, Pearson Studium, 2004, ISBN 3-8273-7098-1.
- J. Billingsley: Mechatronics and Machine Vision, Research Studies Press Ltd., 2000, ISBN 0-86380-261-3.
- Emerging Trends in Mechatronics for Automation, Phoenix Publishing House PVT LTD, 2002, ISBN 81-7484-065-6.
- Chr. D. Rahn: Mechatronic Control of Distributed Noise and Vibration, Springer Verlag, 2001, ISBN 3-540-41859-8.
- D. Nesculescu: Mechatronics, Prentice Hall, 2002, ISBN 0-201-44491-7.