Faculty of Technology and Bionics

HOCHSCHULE RHEIN-WAAL
Rhine-Waal University of Applied Sciences

Module Description

of the study course

„Mechatronic Systems Engineering B.Sc.“

Rev. 1: Stand 18.03.2014

Contents

Module "Fundamentals of Natural Science"

Module name:	Fundamentals of Natural Science
Module code:	Mechanical Engineering: ME_1 Mechatronic Systems Engineering: SE_1 Electronics: EL_1 Industrial Engineering: IE_1
Courses (where applicable):	- Fundamentals of Physics - Fundamentals of Chemistry - Natural Science Laboratory
Semester:	1st Semester
Module coordinator:	Prof. Dr. G. Bastian
Lecturers:	Prof. Dr. G. Bastian Prof. Dr. A. Struck Prof. Dr. A. Fahmi Prof. Dr. N. Shirtcliffe
Language:	English
Place in curriculum:	Core
Timetabled hours:	<u>Fundamentals of Physics:</u> Lecture: 2 HPW Exercise: 1 HPW <u>Fundamentals of Chemistry:</u> Lecture: 2 HPW Exercise: 1 HPW <u>Natural Science Laboratory:</u> Practicals: 2 HPW
Workload:	120 h attendance 30 h preparation and review 30 h exam preparation
Credits:	6
Recommended prerequisites:	
Module objectives:	<u>Fundamentals of Physics:</u> Students will be able to explain and understand technological and scientific phenomena using the knowledge learnt. Processes, effects and phenomena can be approached quantitatively and the necessary physical equations for this can be adapted and applied. The ability to set up, execute, analyse and assess physical

	experiments. Students will be able to present their own results in laboratory reports using appropriate technical terms in English and in digital form. <u>Fundamentals of Chemistry:</u> Students will attain a basic understanding of general chemistry. They will have an understanding of basic inorganic reactions and the relevance of general chemistry to daily life. <u>Natural Science Laboratory:</u> The students are able to work safely in the laboratory using basic laboratory techniques and write lab reports.
Content:	<u>Fundamentals of Physics:</u> • Physical units and measurement errors • Mechanics and kinematics • Oscillations and waves • Optics • Nuclear physics <u>Fundamentals of Chemistry</u> • Structure of matter, atoms, elements and compounds. • Chemical bonds, types of chemical bonds (covalent, ionic, metallic) • Chemical equilibria • Acids and bases, pH-value, strong and weak acids and bases, neutralisation, buffer solutions • Simple introduction to chemical kinetics and thermodynamics • Redox reactions, oxidation and reduction, creating redox equations • Electrochemistry, standard potentials, electrolysis, corrosion, generation of current, applications: • Complex chemistry, nomenclature, structure, applications in technology • Chemistry of elements with regard to technical applications, metals, non-metals <u>Natural Science Laboratory:</u> • Covers content of the corresponding lectures
Assessment:	Fundamentals of Physics and Fundamentals of Chemistry: written examination Natural Science Laboratory: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector, laboratory equipment
Literature:	<u>Fundamentals of Physics</u> Tipler: Physics for Scientists and Engineers <u>Fundamentals of Chemistry</u> John E. McMurry, Robert C. Fay: General Chemistry: Atoms First, Prentice Hall; 2009

Module “Mathematics and IT”

Module name:	Mathematics and IT
Module code:	Mechanical Engineering: ME_2 Mechatronic Systems Engineering: SE_2 Electronics: EL_2 Industrial Engineering: IE_2
Courses (where applicable):	- Introductory Mathematics - Computer-based Engineering Tools
Semester:	1st Semester
Module coordinator:	Prof. Dr. A. Kehrein
Lecturer:	Prof. Dr. A. Kehrein, Prof. Dr. M. Krauledat Prof. Dr.-Ing. D. Nissing
Language:	English
Place in curriculum:	Core
Timetabled hours:	<u>Introductory Mathematics:</u> Lecture: 2 HPW Exercise: 2 HPW <u>Computer-based Engineering Tools:</u> Computer Labs: 2 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	<u>Introductory Mathematics:</u> Students are able to gain knowledge in various ways and learn to organize their work. Students understand basic mathematical concepts and know how to apply standard mathematical methods. They are able to visualize mathematical objects and to interpret mathematical symbols and formulas. They have learned to think, to work and to express themselves with precision. Also they have acquired a feeling for handling numbers. They possess the skills to solve problems on their own and to verify the solutions. They are able to apply numerical as well as graphical solution methods to various tasks. The students will possess general problem solving skills beyond the

	simple application of standard procedures. Computer based Engineering Tools: Students are familiar with the software tool MATLAB and the basics of programming. They are able to perform larger calculations during the course of study and they can implement simple mathematical algorithms and analyse them by using helpful tools such as graphical plots or similar.
Content:	Introductory Mathematics: • Numbers: irrational numbers and the difficulties associated with their representation on a pocket calculator or computer, complex numbers and the Fundamental Theorem of Algebra • Systems of linear equations: Gaussian elimination • Vector algebra and analytic geometry: linear combinations, scalar and vector products, straight lines and planes • Limits: concept and computation, continuity, bisection method • Differential calculus: definition of derivative, rules of derivation, tangent, Newton's method, monotonicity and concavity • Integral calculus: inversion of differentiation – indefinite integral, area calculation – definite integral, Fundamental Theorem of calculus Computer based Engineering Tools: • Use MATLAB commands • Plotting in MATLAB • MATLAB program structures (m-files): scripts and functions • Basic programming structures: conditional statements, loops • Symbolic determination of derivatives and integrals • Numerical integration
Assessment:	Introductory Mathematics: written examination Computer based Engineering Tools: attestation
Forms of media:	Whiteboard, PowerPoint, Projector, PC-Pool
Literature:	James Stewart (2011). *Calculus*. Metric International Version. 7th edition. Brooks/Cole ***Further Readings:*** James Stewart, Lothar Redlin, Saleem Watson (2012). *Algebra and Trigonometry.* 3rd international edition. Brooks/Cole [to catch up on basic mathematics] Stormy Attaway (2012). *MATLAB – A Practical Introduction to Programming and Problem Solving*. 2nd edition. Butterworth-Heinemann.

Module “Statics and Electrical Engineering”

Module name:	Statics and Electrical Engineering
Module code:	Mechanical Engineering: ME_3 Mechatronic Systems Engineering: SE_3 Industrial Engineering: IE_3
Courses (where applicable):	- Statics - Electrical Engineering
Semester:	1st Semester
Module coordinator:	Prof. Dr.-Ing. H. Schütte
Lecturer:	Prof. Dr.-Ing. H. Schütte Prof. Dr.-Ing. G. Gehnen
Language:	English
Place in curriculum:	Core
Timetabled hours:	Statics: Lecture: 2 HPW Exercise: 1 HPW Electrical Engineering: Lecture: 2 HPW Practicals: 1 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	School knowledge of Physics and Mathematics
Module objectives:	Statics: Students are able to sum and decompose coincident forces in two and three dimensions. They are able to calculate moments and combine them in the plane and in space. Building on these skills they can analyse the forces and torques that act on a rigid body in equilibrium conditions. Students are able to determine the centroid of an arbitrary line or area. Based on this knowledge, students are able to analyse planar, spatial and multi-piece structures. Furthermore, they are able to determine the forces in the members of a truss using the method of joints and the method of sections. They are able to determine the distribution of normal, transversal and bending moments for statically determined beams. Students apply the

	knowledge gained in the lectures to regular exercises for solving selected tasks, thereby reinforcing their learning. Electrical Engineering: Students are able to apply the fundamental laws of Electrical Engineering. They know the dangers originating from electric current. They are able to analyse networks of passive linear components as well as to calculate currents and potentials in these networks. They are able to calculate transient processes in capacitors and inductances by means of ordinary differential equations. Additionally, they have knowledge of Alternating Currents insofar as they are able to perform simple calculations of currents, potentials and impedances with sophisticated numbers. In doing so they are able to label and to estimate frequency-dependent behaviour of a circuit. The learned abilities are trained and attested in accompanying tutorials and in the laboratory.
Content:	Statics: 1. Fundamentals 1.1 Definition of force as vector 1.2 Newtonian laws 1.3 Rigid body 1.4 Cutting principle 2. Forces with a common point of origin 2.1 Composition of forces in a plane 2.2 Dismantling of forces in a plane 2.3 Equilibria in a plane 3. Force systems and equilibrium of the rigid body 3.1 Forces in plane and in space 3.2 Torque vector 4. Median point 4.1 Median point and centre of mass of a body 4.2 Centroid of an area 4.3 Centroid of a line 5. Bearing reactions 5.1 Plain structures 5.2 Spatial structures 5.3 Multi-piece structures 6. Frameworks 6.1 Static specification 6.2 Setup of a framework 6.3 Determining stress in the bars (Maxwell diagram) 7. Beam, frame and arc 7.1 Cutting conditions for straight beam

	7.2 Cutting conditions for frames and arcs <u>Electrical Engineering:</u> • General introduction to Electrical Engineering, historical backgrounds • Electrostatics: atoms, electrons and charge • Coulomb‘s law • Current as charge movement • Electric potential and voltage • Resistors, Ohm’s law • Electric safety • Series and parallel circuit of resistors • Kirchhoff’s laws • Mesh Analysis • Electric power and energy • Heterodyne principle • Thevenin’s theorem, alternative sources • Fundamentals of capacitors • Transient processes at capacitors • Induction law • Inductivities and their Analoguey to capacitors • Transient processes at inductivities • Fundamentals of alternating currents engineering • Calculating with complex numbers in alternating currents engineering, pointer indication • Root mean squares and peak values • Calculation of impedance and admittance • Networks in complex notation, phasor • Energy and power in alternating current nets • Frequency-dependent behaviour
Assessment:	Statics: Written examination Electrical Engineering: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector, Laboratory experiments
Literature:	<u>Statics:</u> Meriam,J.L., Kraige, L.G.: Engineering Mechanics: Statics SI-Version, 7th ed., ISBN 978-1-118-38499-2 Ferdinand Beer, Jr. Johnston, John DeWolf, David Mazurek: Vector Mechanics for Engineers: Statics, Ninth edition, ISBN 978-0-07-352923-3 <u>Electrical Engineering:</u> R.L. Boylestad: Introductory Circuit Analysis, 12th edition, Pearson, 2010 G. Hagmann: Grundlagen der Elektrotechnik (Fundamentals of Electrical Engineering), 15th edition, AULA Verlag, 2011 with G. Hagmann: Aufgabensammlung

	zu den Grundlagen der Elektrotechnik (Set of exercises regarding Fundamentals of Electrical Engineering), 14th edition, AULA Verlag, 2010 ***Further Readings:*** Course materials from the lecturer Laboratory documents und Exercises from the lecturer

Module “Creativity and Conflict Management”

Module name:	Creativity and Conflict Management
Module code:	Mechanical Engineering: ME_4 Mechatronic Systems Engineering: SE_4 Electronics: EL_4 Industrial Engineering: IE_4
Courses (where applicable):	- Conflict Management - Creativity
Semester:	1st Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	External lecturers
Language:	English
Place in curriculum:	Core
Timetabled hours:	Conflict Management: Lecture: 1 HPW Exercise: 1 HPW Creativity: Lecture: 1 HPW Exercise: 1 HPW
Workload:	60 h attendance 90 h preparation and review
Credits:	5
Recommended prerequisites:	
Module objectives:	Conflict Management: Students will understand the fundamental concepts of Conflict Management. They have the ability to analyse conflict causes and to understand conflict dynamics. They have methods at their disposal to deal constructively with conflict situations and to avoid escalation. Creativity: Students are able to select an appropriate creativity method from a catalogue to apply in a given situation. They understand classification and didactics. Students recognise concrete problems and challenges and work on solutions with suitable techniques. They are able to use the creative methods safely and apply them in a goal-oriented way. Students know the relationship between innovation,

	creativity, and ideas, and are able to confidently differentiate between them. They change their perspective towards creativity and know that only a diligent and permanent application of these techniques leads to success.
Content:	<u>Conflict Management:</u> 1. Introduction • What is a “conflict”? • What different forms of conflicts do exist? 2. Fundamentals of communication • Levels of communication (verbal/non-verbal) • Individual “filters” and their impact on our perception • Active listening • “Four ears” model of Schulz von Thun 3. Body language, voice and the power of the “unconsciousness” • Stress and its impact • Body language & voice • Priming 4. Dealing with conflicts I • Dynamics of conflicts – conflict escalation • Escalating and deescalating communication • The concept of the „Inner Team“ • Different approaches dealing with conflicting situations 5. Dealing with conflicts II • The concept of „triangulation“ • Mediation • „Non-violent communication“ according to Rosenberg • Preparing difficult conversations • Receiving and giving feedback 6. Handling differences • Differences in organizations & society • Dealing with differences: Value square and development triangle according to Schulz von Thun • Human profile in conflict field of complementary poles • Diversity Management in Organisations – Success through active utilisation of “differences” 7. Framework for collaboration • How teams develop and become “productive” • Meeting and moderation • Handling changes – Change Management <u>Creativity:</u> • Well-structured and badly-structured problems • Creativity techniques – Fundamentals

	• Creativity myths – Mindmapping • Lateral thinking • Innovation types – Brainwriting • Habits of creative people • Product innovations – Checklist methods • Morphological box – Diffusion of innovations • Innovation Management – Fundamentals • Characterisation of creativity methods • Field trip to a place of inspiration…
Assessment:	Conflict Management: Attestation Creativity: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector, Flip-Chart, Moderation kit
Literature:	<u>Creativity:</u> Michael Michalko: Thinkertoys: A Handbook of Creative -Thinking Techniques, ISBN 978-1-58008-773-5, Ten Speed Press, 2006 David Silverstein, Philip Samuel und Neil DeCarlo: The Innovator's Toolkit, 1st edition, ISBN: 978-0-470-34535-1, John Wiley & Sons, 2008 <u>Conflict Management:</u> Joseph P. Folger, Marshall Scott Poole, Rendall K. Stutman: Working through conflict; Strategies for relationships, groups and organizations, 6th edition, Pearson Education, 2009 Roy M. Berko, Andrew D. Wolvin, Darlyn R. Wolvin: Communicating; A social, career and cultural focus, Pearson Education, 2010 ***Further Readings:*** Jurgen Wolff: Creativity, 1st edition, ISBN: 978-0-273-72467-4, Financial Times Prentice Hall, 2009 Edward De Bono: Serious Creativity, ISBN: 978-0-00-637958-4, Harper Collins Publ., 1995 Paul Trott: Innovation Management and New Product Development, 5th revised edition, ISBN: 978-0-273-73656-1, Financial Times Prent. Int, 2011 Friedmann Schulz von Thun: Miteinander reden 1; Störungen und Klärungen; (Communicate 1; Troubles and Clarifications)

	ISBN: 3 499 17489 8, Rowohlt Verlag, 1998 Friedmann Schulz von Thun: Miteinander reden 2; Stile, Werte und Persönlichkeitsentwicklung (Communicate 2; Phrasing, values and personality development), ISBN: 3 499 18496 6, Rowolth Verlag, 1998

Module “Technical Drawing”

Module name:	Technical Drawing
Module code:	Mechanical Engineering: ME_5 Mechatronic Systems Engineering: SE_5 Electronics: EL_5 Industrial Engineering: IE_5
Courses (where applicable):	
Semester:	1st Semester
Module coordinator:	Prof. Dr.-Ing. P. Kisters
Lecturer:	Prof. Dr.-Ing. P. Kisters
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 2 HPW
Workload:	60 h attendance 90 h preparation and review
Credits:	5
Recommended prerequisites:	
Module objectives:	After successfully concluding the module, students should be able to sketch ideas in two and three dimensions. Using this, they should be able to draw and read technical drawings for various projection methods. They are able to produce drawings for given components independently and according to internationally relevant standards, to define the necessary views and sections, to prepare the drawing for the intended purpose and to compile the necessary parts lists. Furthermore they master the drawing of common machine elements. They can independently develop pattern for sheet materials and determine interpenetrations of solids. Students prove their learning progress with independently produced technical drawings. They learn to use checklists to ensure drawings according to international standards. They competently document what they have learned according to valid referencing rules.
Content:	• General Introduction, Importance of Technical Drawing • Standardisation: DIN, EN, ISO • Orthographic projection • Isometric projection and orthogonal projection • Types of drawing: component drawings, assembly

	drawings, variants drawings • Sheet sizes, frames and title block • Parts lists: type and representation • Sections and sectional views • Creating auxiliary views • Application of lines, line groups and line widths • Objectives of dimensioning and application-oriented dimensioning • Types of dimensioning and international differences • Tolerances and deviation limits • ISO system of fits: shaft-based system, hole-based system • Geometric tolerances • Definition of surface properties • Representation of weld seam, types and thicknesses as well as additional details required for the welding process • Graphic presentation of standard parts (bolts, threaded connections, circlips, roller bearings) • Presentation of common machine elements • Stress-related design and application of undercuts • Development of pattern • Interpenetration of solid bodies and determination of interpenetration curves • Introduction to graphic presentation of electric/electronic components, draughting of circuit diagrams
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Colin H. Simmons, Dennis E Maguire, Neil Phelps: Manual of Engineering Drawing – Technical Product Specification and Documentation to British and International Standards, 3rd edition, Elsevier/Newnes, 2006 Cecil Jensen, Jay D. Helsel, Dennis R. Short: Engineering Drawing & Design, 7th revised edition, McGraw-Hill Higher Education, 2007 ***Further Readings:*** H.C. Spencer, J.T. Dygdon, J.E. Novak: Basic Technical Drawing, 8th edition, McGraw-Hill, 2004 Hans Hoischen, Wilfried Hesser: Technisches Zeichnen – Fundamentals, Normen, Beispiele, Darstellende Geometrie (Technical Drawing – Fundamentals, standards, examples, descriptive geography), 32 revised and updated edition, Cornelsen-Verlag, 2009 Course materials from the lecturer Exercises from the lecturer

Module “Cross-Cultural Project Management”

Module name:	Cross-Cultural Project Management
Module code:	Mechanical Engineering: ME_6 Mechatronic Systems Engineering: SE_6 Electronics: EL_6 Industrial Engineering: IE_6
Courses (where applicable):	- Cross-Cultural Management - Project Management
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. I. Volosyak
Lecturer:	Prof. Dr.-Ing. I. Volosyak Prof. Dr.-Ing. D. Untiedt
Language:	English
Place in curriculum:	Core
Timetabled hours:	Cross-Cultural Management: Lecture: 2 HPW Project Management: Lecture: 1 HPW Exercise: 1 HPW
Workload:	60 h attendance 90 h preparation and review
Credits:	5
Recommended prerequisites:	
Module objectives:	Cross-Cultural Management: Students know different cultures and ways of living and acting successfully in different social surroundings. Through this course, they are able to define their own cultural situation, to recognise the defining elements of other cultures, and to develop a familiarity with different cultures. The goal is to develop the student‘s ability to evaluate his own and public images and to commit to corresponding interactive perception and action. Project Management: After finishing this module, students will appreciate the need for project planning and are able to distinguish between project objectives and functional goals. They are able to define and document the objectives of a project. Depending on the type of project, they are able to design a

	suitable project structure and plan of execution. They are able to estimate project risks using a set of tools to analyse the project execution based on time and content and to communicate and document results by creating informative target group oriented presentations.
Content:	<u>Cross-Cultural Management:</u> • Cultures and their key aspects • Cultural identity and history • Globalisation of markets and economies • Negotiations in these situations • Development of a culture-related, management-oriented and socio-cultural behaviour settings • Living successfully in new and strange cultures • Discovering styles, fashions and scenes in different cultures • Copybook descriptions and methods <u>Project Management:</u> Projects as a modern form of working • Comparison of Project and Line Management • Challenges of Project Management Differentiation and contents of projects • Project phases • Developing project objectives (SMART) • Documentation: brief description of the project, project proposal Project organisation • Embedding projects in existing organisations • Typical project organisation form • Role descriptions of project committees Stakeholder Management • Analysis of influence and demand • Developing a strategy and action plan for targeted contact Project Planning • Milestones and activities • Project structure plan Network Techniques • Critical Path Method (CPM) • Programme Evaluation and Review Technique (PERT) Risk Management • Strategies for handling risks • Continuous risk assessment • Change Management within the project Project Documentation and Reports

	• Reports for different recipients • Planning of project meetings • Handling expectations
Assessment:	Cross-Cultural Management: Attestation Project Management: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Cross Cultural Management:</u> Fred E. Jandt: An Introduction to Intercultural Communication (7th Edition), Sage Publications, 2013 Marie-Joelle Browaeys: Understanding Cross-Cultural Management (2nd Edition), Pearson Education, 2011. <u>Project Management:</u> J. Kuster, E. Huber et al.: Handbuch Projektmanagement (Guide to Project Management), Springer-Verlag, 2008 ISBN 978-3-540-7632-8 P. Clements/Jack Gido: Effective Project Management. Thomson South-Western, 2006. ***Further Readings:*** Craig Storti: Cross-Cultural Dialogues: 74 Brief Encounters with Cultural Difference, Nicholas Brealey Publishing, 1994. Patrick L. Schmidt: In search of Intercultural Understanding, Meridian World Press, 2007 Sylvia Schroll-Machl: Doing Business with Germans, Vandenhoeck & Ruprecht, 2013 Standard: DIN 59901 Rory Burke: Project Management. James 4th edition, John Wiley & Sons, 2003 Erling S. Andersen/Kristoffer V. Grude/Tor Haug: Goal Directed Project Management. 3rd ed., Kogan Page, London, 2004 International Project Management Association (www.ipma.ch) Project Management Institute (www.pmi.org): Project Management Body of Knowledge (PMBok) GPM Deutsche Gesellschaft für Projektmanagement (German Project Management society) (www.gpm-ipma.de)

Module “Materials and Testing”

Module name:	Materials and Testing
Module code:	Industrial Engineering: IE_7 Mechatronic Systems Engineering: SE_7
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. R. Sicking
Lecturer:	Prof. Dr.-Ing. R. Sicking
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW Practicals: 1 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	Students are able to • define crystal structures and different classes of metals and ceramics • report with basic knowledge concerning alloy systems, phase transformations, strength increase mechanisms as well as mechanical and technological properties of metals. • identify basic structures of polymers and to specify isometric structures • perform different testing and analysis methods for materials characterization • assign the link between microstructure and macroscopic properties for polymers, cerymics, glass and metals • select appropriate materials with regard to its engineering application
Content:	• Introduction into atomic structure and built-up of single and polycrystals, lattice structures, lattice defects, alloying systems and stress-strain diagram • Strength increase mechanisms (cold forming/plastic

	deformation, Hall-Petch, solid solution, grain fining, precipitates) and phase transformations • Mechanical load, fracture, metals groups as well as first introduction into corrosion • Equilibrium: component / phase / microstructure, 2-component-system / equilibrium diagrams, lever rule • Classification and sorts of polymers • Recognize polymer states, description of polymer chain structure, chain configurations, structural isomery, cross links and branches of long chains • Structural changes by temperature and glass transition • Link between structure and macroscopic properties of polymers and metals • Microstructure and properties of ceramics and glass • Introduction of important testing methods (hardness, impact test, tensile test, microscopic techniques, ultrasonic inspection, surface roughness) • Overview of main manufacturing process groups • In addition specific application examples are presented
Assessment:	Written Examination
Forms of media:	Whiteboard, PowerPoint, Projector, Laboratory equipment
Literature:	M. F. Ashby, D. R. Jones Engineering Materials 2 – An Introduction to Microstructures, Processing and Design, 3rd ed., ISBN-13 978-0-7506-6381-6, 2006 C. B. Carter, M.G. Norton Ceramic Materials – Science and Engineering, 2. ed., ISBN 978-1-4614-3522-8, Springer Verlag, 2013 **Further Readings:** E. Hornbogen, G. Eggeler, E. Werner Werkstoffe: Aufbau und Eigenschaften von Keramik-, Metall-, Polymer- und Verbundwerkstoffen (Materials: Structure and Features of Ceramic, Polymeric and Composite Materials), 9th completely rev. ed., ISBN 978-3540718574, Springer, 2008 M. F. Ashby, D. R. H. Jones Engineering Materials 1 - An Introduction to Properties, Applications and Design, 4th ed., ISBN 978-0-08-096665-6, Elsevier, 2012 George M. Crankovic Metals Handbook: Materials Characterization, 9th ed., ISBN 978-0871700162, ASM Intl., 1989 G. W. Ehrenstein

	Polymerwerkstoffe – Struktur – Eigenschaften – Anwendungen, 3. ed., ISBN 978-3-446-42283-4, Carl Hanser Verlag, 2011 E. Saldivar-Guerra, E. Vivaldo-Lima Handbook of Polymer Synthesis, Characterization and Processing, 1. ed., ISBN 978-0-470-63032-7, Wiley, 2013 Jean Louis Halary, Francoise Laupretre, and Lucien Monnerie Polymer Materials: Macroscopic Properties and Molecular Interpretations, 1. ed., ISBN 978-0470616192, Wiley & Sons., 2011

Module “Applied Mathematics”

Module name:	Applied Mathematics
Module code:	Mechanical Engineering: ME_8 Mechatronic Systems Engineering: SE_8 Electronics: EL_8 Industrial Engineering: IE_8 Biomaterials Science: BM_6
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr. A. Kehrein
Lecturer:	Prof. Dr. A. Kehrein
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 2 HPW
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	Course “Introductory Mathematics”
Module objectives:	Students are able to use advanced mathematical concepts and methods and, in particular, are able to work with multivariate functions. They master modelling with differential equations. Students practice their general social skills working in teams. They specifically train to communicate in precise mathematical terms. By means of their homework, students further improve their problem solving skills.
Content:	• Integral calculus: substitution rule, integration by parts, partial fraction decomposition, improper integrals • Power series: Taylor series, approximations using partial sums • Differential calculus of several variables: partial derivatives, gradient, extrema • Ordinary differential equations: direction field, separating variables, linear differential equations of first and second order • Linear algebra: matrices, determinants, inverse matrix

Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	James Stewart (2011): *Calculus*. Metric International Version. 7th edition. Brooks/Cole ***Recommended Video Lectures:*** Mattuck, Arthur, Haynes Miller, Jeremy Orloff, and John Lewis. *18.03SC Differential Equations,Fall 2011*. (Massachusetts Institute of Technology: MIT OpenCourseWare), http://ocw.mit.edu (Accessed 08 May, 2013). License: Creative Commons BY-NC-SA Strang, Gilbert. *18.06SC Linear Algebra,Fall 2011*. (Massachusetts Institute of Technology: MIT OpenCourseWare), http://ocw.mit.edu (Accessed 08 May, 2013). License: Creative Commons BY-NC-SA

Module „Elastostatic und Electronics“

Module name:	Elastostatics and Electronics
Module code:.	Mechanical Engineering: ME_9 Mechatronic Systems Engineering: SE_9
Courses (where applicable):	Elastostatics Electronics
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. H. Schütte
Lecturer:	Prof. Dr.-Ing. H. Schütte Prof. Dr.-Ing. G. Gehnen
Language:	English
Place in curriculum:	Core
Timetabled hours:	<u>Elastostatics:</u> Lecture: 2 HPW Exercise: 1 HPW <u>Electronics:</u> Lecture: 2 HPW Exercise: 1 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Statics und Electrical Engineering”
Module objectives:	<u>Elastostatics</u> After passing the module, the student is able to design and calculate mechanical elements of machines. The design and dimensioning is in particular based on the calculation of the strength of the mechanical part. <u>Electronics</u> The student knows the fundamental conduction mechanisms in semi-conductors as well as effects related to the connection of semi-conductors with different doping. The student understands the function of diodes and transistors and is able to calculate rations of current and voltage based on characteristic curves and approximations. Besides that, the student is able to design simple circuits involving operational amplifiers. The student knows about the frequency behavior of semi-conductor

	components and is able to apply practical approximations. The student knows the fundamentals of digital circuits and logical elements.
Content:	<u>Elastostatics</u> • Stress and strain in bars (stress, strain, material properties) • State of stress (stress tensor, plane state of stress, equilibrium conditions) • State of deformation and elasticity law • (State of deformation, elasticity law, strength theories) • Beam bending (geometrical moments of inertia, symmetrical bending, differential equation of the bending line, influence of shear, oblique bending) • Torsion • Buckling (Euler buckling) <u>Electronics:</u> • Semi-conductors: Composition and conduction mechanisms • Doping of semi-conductors • pn-transition and diodes • Application of diodes • Special designs of diodes: Z-diodes, Schottky-diodes, LED • Bipolar transistors, fundamentals and characteristic curves • Transistor circuits • Field effect transistors • Fundamentals of operational amplifiers • Circuits with operational amplifiers • Frequency behaviour : oscillators, timer and filters • Semi-conductors in digital circuits • Logic gates and their connection • Current supply circuits
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Elastostatics:</u> Beer, F.P., Johnston, R.E: Mechanics of Materials, 6th Global Edition, McGraw-Hill, 2011 Gross, Hauger, Schnell, Schröder, Bonet: Engineering Mechanics 2: Mechanics of Materials, Springer-Book, 2011 <u>Electronics:</u> R. L. Boylestad, L. Nashelsky:

	Electronic Devices and Circuit Theory,10th edition, Pearson, 2009 ***Further Readings:*** M. Rashid: Microelectronic Circuits, 2nd Edition, Cengage Learning, 2011 Tietze, Schenk: Halbleiterschaltungstechnik, Springer Verlag, 2009 Horowitz, Hill: The Art of Electronics, Cambridge University Press; 1989

Module “IT-Programming”

Module name:	IT-Programming
Module code:	Mechanical Engineering: ME_10 Mechatronic Systems Engineering: SE_10 Electronics: EL_10 Biomaterials Science: BM_9
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr. M. Krauledat
Lecturer:	Prof. Dr. M. Krauledat
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Practicals: 2 HPW
Workload:	60 h attendance 90 h preparation and review
Credits:	5
Recommended prerequisites:	Course “Computer-based Engineering Tools”
Module objectives:	After successfully finishing the module, students are able to • develop short programs in C • analyze program code • recognize limitations and complexity of computer based operations • Use algorithmic concepts such as recursion • transfer technical problems to program code
Content:	Programming • Introduction to Programming in C • Tools for program development • Data types, operators and terms • Input and output • Flow control • Program structures • Functions • References and pointers • Data structures • Searching and Sorting

	• Recursion • Practical programming exercises with C •
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	King, K.N. (2008) *C Programming – A Modern Approach*. 2nd edition . Norton Griffiths, David and Griffiths, Dawn (2012) *Head First C.* O'Reilly ***Further Readings:*** Kernighan, Brian W. and Ritchie, Dennis M.: The C Programming Language, 2nd edition, Prentice Hall International, ISBN 978-0131103627, 1988 M. Sipser, „Introduction to the theory of computation" (3rd ed.), Cengage Learning 2013 J. G. Brookshear, „Computer Science – an overview" (11th ed.), Pearson 2012 ***Recommended Video Lectures:*** Malan, David J.: *CS 50 Introduction to Computer Science I, 2011- 2013*. (Harvard University: OpenCourseWare) http://cs50.tv/2011/fall/ (Accessed 02 Mar, 2014). License: Creative Commons BY-NC-SA

Module “Technical Design”

Module name:	Technical Design
Module code:	Industrial Engineering: IE_11 Mechatronic Systems Engineering: SE_11
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. P. Kisters
Lecturer:	Prof. Dr.-Ing. P. Kisters
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 2 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Technical Drawing” Course “Statics”
Module objectives:	After successfully finishing the module, students are able to transfer physical principles to the calculations of components. They recognise fluxes and disturbances of those and present constructive improvement measures. Students know essential design rules and apply them to the designing of components. They conduct design calculations of simple machine elements and are finally able to select and design them under consideration of the aspects of reliability, material use and cost. They are able to calculate potentials relating to component strains and to evaluate them compared to given component key figures.
Content:	• Introduction to strength calculation of real components • Material characteristics, elastic and plastic deformation, yield strength, fracture strength • Equivalent stress concepts and theories for calculation of machine elements • Definition of limit and long life fatigue strength, influence of stress cycles on component lifespan • Influence of design on component strains, notch effects and frame influence • Dimensioning and calculation of elastic springs under torsional stressing • Design of springs and spring systems

	• Systematic arrangement of component joints • Dimensioning and designing of bolt joints • Dimensioning and designing of compression joints with spilt and slotted hub • Theoretical fundamentals of threads, selection and application limits of screwed joints • Designing and calculating of screwed joints under consideration of different load conditions • Welding techniques and applications as well as weldability • Representation of various verification concepts • Design, calculation and structural limits of welding joints • Design of roller bearings • Roller bearing calculation under consideration of operating conditions (temperature, lubrication) and combined axial/radial strain
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Richard G. Budynas: Shigley's Mechanical Engineering Design, Student international edition, 8th revised edition, ISBN 978-0071268967, McGraw-Hill College, 2009 Robert L. Mott: Machine Elements in Mechanical Design, 4th edition, ISBN 978-0130618856, Prentice Hall, 2003 ***Further Readings:*** Roloff/Matek Maschinenelemente: Normung, Berechnung, Gestaltung (Machine Elements: Standardisation, Calculation, Design), 20th revised and expanded edition, ISBN 978-3834814548, Vieweg Teubner, 2011 Decker: Maschinenelemente: Funktion, Gestaltung und Berechnung (Machine Elements: Function, Design and Calculation), 18th updated edition, ISBN 978-3446426085, Carl Hanser Verlag, 2011 Course materials from the lecturer Exercises from the lecturer

Module “Thermodynamics”

Module name:	Thermodynamics
Module code:	Mechanical Engineering: ME_12 Mechatronic Systems Engineering: SE_12 Industrial Engineering: IE_12
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. J. Gebel
Lecturer:	Prof. Dr.-Ing. J. Gebel
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW Practicals: 1 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Fundamentals of Natural Science” Module “Applied Mathematics”
Module objectives:	Students know the terminology of intensive and extensive state variables (temperature, pressure, density or enthalpy, entropy, exergy and anergy) and are able to apply them correspondingly. They are able to apply the first and second law of thermodynamics for solving thermodynamic problems and are able to analyse thermodynamic cycles. With this knowledge, students are able to analyse vapour and gas power systems such as car engines or gas turbines and to determine thermal efficiencies. In the laboratory framework, students learn how to measure temperature and pressure, how a boiling curve can be determined with a Marcet boiler, and how an ideal gas behaves under different conditions. They learn how to operate thermodynamic plants such as steam engines, hot air engines (Stirling motor) and heat pumps, especially with regard to valid safety standards.
Content:	Based on a detailed elaboration of the fundamentals of thermodynamics, the first and second law of thermo-dynamics will be introduced. This offers the requisite knowledge to be able to deal with thermodynamic

	processes like vapour and gas power systems, refrigeration and heat pump systems. In detail, the module contains the following: 1. General fundamentals 1.1 System and control volume 1.2 State and state variables 1.3 Process and change of state 1.4 Evaluating properties 2. First law of thermodynamics 2.1 Work and heat 2.2 Conservation of energy for a control volume 2.3 First law for steady-state flow processes 3. Second law of thermodynamics 3.1 Second law for closed systems 3.2 Entropy as state variable 3.3 Anergy and exergy 4. Gas power systems 4.1 Fuels and combustion equations 4.2 Heat value and fuel value 4.3 Molar enthalpies of reaction and formation 4.4 Ordinary gas turbine plant 4.5. Internal combustion engines 5. Vapour power systems 5.1 Transformation of primary energy into electric energy 5.2 Conventional thermal power plants 5.3 Steam power plants 5.4 Gas and steam turbine power plants (GuD) 6. Refrigeration and heat pumps
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector, Tablet
Literature:	Michael J. Moran, Howard Shapiro: Fundamentals of Engineering Thermodynamics, SI-Version, ISBN 978-0-470-54019-0 ***Further Readings:*** Robert Balmer: Modern Engineering Thermodynamics, ISBN 978-0-12-374996-3 Yunus A. Cengel, Michael A. Boles: Thermodynamics An Engineering Approach: 7thedition in SI-Units, ISBN 978-007-131111-3 Claus Borgnakke, Robert E. Sonntag: Fundamentals of Thermodynamics, International Student Version, 7thedition, ISBN 978-0-470-17157-8

Module "Manufacturing and Quality"

Module name:	Manufacturing and Quality
Module code:	Mechanical Engineering: ME_13 Mechatronic Systems Engineering: SE_13 Industrial Engineering: IE_13
Courses (where applicable):	- Manufacturing Technology - Integrated Management Systems
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. A. Klein
Lecturer:	Prof. Dr.-Ing. A. Klein
Language:	English
Place in curriculum:	Core
Timetabled hours:	<u>Manufacturing Technology:</u> Lecture: 2 HPW Practicals: 1 HPW <u>Integrated Management-Systems:</u> Lecture: 2 HPW Exercise: 1 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	Students have basic knowledge of manufacturing engineering. They have basic and application knowledge of methods used in industrial production. After finishing this module, students have a deeper knowledge of integrated management systems (IMS) and are able to apply methods and techniques of quality management, environment management and work safety management. Here industrial production is the common spotlight.
Content:	<u>Fundamentals of Manufacturing Technology:</u> • Primary forming (casting and optimum casting design) • Transforming (traction, pressure, bend, thrust and combined transformation methods) • Separating (cutting, chipping, skimming) • Joining (substance, form and frictional methods) • Coating (thin layer, PVD and CVD methods)

	• Change of substance properties (hardening and annealing processes) • Rapid prototyping (stereolithography, solid ground curing, selective laser sintering, fused deposition modelling, three dimensional printing) • Manufacturing laboratory <u>Integrated Management Systems:</u> • Quality Management - DIN ISO 9001 - Six Sigma (e. g. DMAIC) - Quality Function Deployment (House of Quality) - FMEA (Process- und Product-FMEA) - Risk Management - Quality Assurance: Capability, Test scheduling, Evaluation, Applied Statistics, Statistical Process Control • Environmental Management DIN EN ISO 14001 • Work safety BS OSHAS 18001 • General Management Systems - Structure and implementation of Management Systems - Corporate Governance, Compliance
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Kalpakjian & Schmid: Manufacturing Processes for Engineering Materials, 5th edition, ISBN 978-0132272711, Prentice Hall, 2008 Pardy, Wayne, Andrews, Terri: Integrated Management Systems, Government Institutes, 2010 ***Further Readings:*** Klocke, F. (Autor); Kuchle, A. (Übersetzer): Manufacturing Processes 1: Cutting: Lathing, Milling, Drilling; Springer Berlin Heidelberg; 1st edition, 2011 Klocke, F. (Autor); Kuchle, A. (Übersetzer): Manufacturing Processes 2: Grinding, Honing, Lapping; Springer Berlin Heidelberg; 1st edition, 2009 Fischer, Ulrich; Gomeringer, Roland; Heinzler, Max; Kilgus, Roland; Näher, Friedrich: Mechanical and Metal Trades Handbook. Europa-Verlag, 2013

	Sanders, Donald A., Scott, C. Frank: Passing Your ISO 9000/QS-9000 Audit, CRC Press LLC, 1997 May, Constantin, Schimek, Peter: TPM Total Productive Management, 2nd edition, CETPM Publishing, 2009 Hoyle, David: ISO 9000 Quality Systems Handbook, 6th edition, Routledge, 2009 Kelly, John M: IMS: The Excellence Model, BSI Business Information, 2004 Lindsay, Evans: The Management and Control of Quality, 8th edition, South-Western, Cengage Learning, 2011 DIN ISO EN 9000ff, raw documents BS OHSAS 18001; DIN ISO EN 14000 f, raw documents

Module “Dynamics and Statistics”

Module name:	Dynamics and Statistics
Module code:	Mechanical Engineering: ME_14 Mechatronic Systems Engineering: SE_14
Courses (where applicable):	- Dynamics - Numerics and Statistics
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. H. Schütte
Lecturer:	Prof. Dr.-Ing. H. Schütte Prof. Dr. A. Kehrein
Language:	English
Place in curriculum:	Core
Timetabled hours:	Dynamics: Lecture: 2 HPW Exercise: 2 HPW Numerics and Statistics: Lecture: 2 HPW Exercise: 1 HPW
Workload:	105 h attendance 15 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Modules Mathematics and IT, Applied Mathematics, Statics and Electrical Engineering, Elastostatics and Electronics
Module objectives:	Dynamics: After successfully finishing the module, students are able to formulate problems in technical dynamics (creating equations of motion) and to analyse and solve them. Numerics and Statistics: The students know the accuracy limitations of machine computations. Based on this, they are able to select suitable numerical methods. Students are able to interpret data, summarize it in an informative way and display it graphically. The students acquire a feeling for random effects by performing and analysing chance experiments. Furthermore, students know the basic concept of estimating a population quantity from sample data.

Content:	Dynamics: • Movement of ground point (kinematics, kinetics) • Kinetics of a ground point system • Movement of a rigid body • Principles of mechanics • Oscillations • Relative movement Numerics and Statistics: Numerics: • Round-off errors, truncation errors, loss of significant digits • Iterative methods for solving equations • Numerical integration: midpoint and trapezoid rule, Romberg scheme • Numerical differentiation, finite differences, solving initial value problems Statistics: • Basic concepts: population, sample, qualitative/quantitative data, grouping data, histograms, scatter plot, stem-leaf-diagrams • Mean, median, variance, standard deviation, z values (standard units), quartiles, box plots • Linear regression • Probability: sample space, Law of Large Numbers, conditional probability, tree diagrams, Bayes' Theorem • Random variables, expectation value, variance, normal distribution • Sample theory: sample average, Central Limit Theorem, variance of sample average
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Dynamics: Meriam,J.L., Kraige, L.G.: Engineering Mechanics: Dynamics SI-Version, 7th ed. (2013) Gross, Hauger, Schröder, Wall, Govindjee: Engineering Mechanics 3: Dynamics Springer Lehrbuch, (2011) Numerics and Statistics: Numerics: Acton (1996). *Real Computing made Real*. *Preventing Errors in Scientific and Engineering Calculations.* Dover Statistics: DeVeaux, Velleman (2004). *Intro Stats*. Pearson.

	Further Readings: Burden, Faires (2011). *Numerical Analysis*. 9th international edition. Brooks/Cole Devore (2008). *Probability and Statistics for Engineering and the Sciences*. 7th international student edition. Brooks/Cole

Module “Fundamentals of Process Engineering”

Module name:	Fundamentals of Process Engineering
Module code:	Mechanical Engineering: ME_15 Mechatronic Systems Engineering: SE_15 Industrial Engineering: IE_16
Courses (where applicable):	
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. J. Gebel
Lecturer:	Prof. Dr.-Ing. J. Gebel
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW Practicals: 1 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Fundamentals of Natural Science” Module “Applied Mathematics” Module “Thermodynamics”
Module objectives:	Students master basic operations for material conversion of mechanical and thermal processes. They know the fundamentals of fluid mechanics and are able to analyse processes with the aid of dimensional analysis and the law of similarity. Students are able to generate full process chains from unit operations. In this regard, they are able to compile mass, material and energy balances for closed and open systems. They are able to draw block flow diagrams, process flow diagrams and piping and instrumentation diagrams (P&I). By handling exemplary processes in the exercises such as sugar production, drinking water purification and desalination of seawater, students will be able to apply the knowledge gained in a concrete way. In the laboratory framework, students perform tests on pressure losses within tubes and fittings. They are able to determine the performance curve of a centrifugal pump, and to recognize cavitation within nozzles and pumps. They are able to operate a sedimentation plant as well as a CO_2 gas absorption plant.

Content:	1. Process Flow Sheets - Block diagrams - Process flow sheets - Piping and instrumentation diagram (P&I) 2. Dimensional Analysis and Similitude 3. Mechanical Process Engineering 3.1 Operations Involving Particulate Solids - Size reduction (Crushing and grinding) - Mechanical separations (Screens, sieves and filter) - Sieve analysis 3.2 Fluid Mechanics - Basic equations for fluid flow - Incompressible flow in pipes and channels - Hagen-Poiseuille equation / Bernoulli equation - Stokes law 4. Thermal Process Engineering 4.1 Heat Transfer - Heat transfer by conduction - Heat transfer by convection - Multiple-Effect Evaporation
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector, Tablet
Literature:	Warren L. McCabe, Julian Smith, Peter Harriot: Unit Operations of Chemical Engineering, 7th edition, ISBN 978-0-07-284823-6 ***Further Readings:*** Ullmann's Chemical Engineering and Plant Design Wiley-VCH, 2004, ISBN 978-3-52-731111-8, 2 vols. Robin M. Smith: Chemical Process: Design and Integration, ISBN 978-0-471-48681-7 K.S.N. Raju: Fluid Mechanics, Heat Transfer, and Mass Transfer Chemical Engineering Practice John Wiley & Sons, 2011 ISBN 978-0-470-63774-6 Merle C. Potter, David C. Wiggert, Bassem H. Ramadan: Mechanics of fluids Fourth edition, ISBN 978-1-4390-6203-6

Module “Power Electronics and Drives”

Module name:	Power Electronics and Drives
Module code:	Mechatronic Systems Engineering: SE_16 Electronics: EL_16
Courses (where applicable):	Power Electronics and Drives
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. R. Schmetz
Lecturer:	Prof. Dr.-Ing. R. Schmetz
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 2 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	SE: Module “Statics and Electrical Engineering“, Module “Elastostatics and Electronics“ Module “Dynamics and Statistics” EL: Module “Fundamentals of Electrical Engineering and Mechanics” Module “Analog Electronic Circuits” Module “Alternating Currents and Mechanics”
Module objectives:	After completion of the module students are able to • understand the fundamentals of converting electrical energy • describe components of power electronics as well as different regulator circuits and modulation methods for conversion • understand the workings of electric drives and to compare them with mechanical, hydraulic, pneumatic and mechatronic systems, • describe the manifold areas of application for electric drives and to explain their advantages and disadvantages, • identify specific functions of typical components of electric drives, • perform simple calculations on them as well as arrange

	them in an electrical circuit diagram, lay-out and dimension simple electric drives with inverters.
Content:	Objectives of power electronics as well as basic functionality and characteristics of inverters Components of power electronics Converter and inverter types Basic characteristics of electric drives with inverters Components of electric drives with inverters Feedback of powered machines Design and dimensioning of electric drives with inverters and selected applications
Assessment:	Written examination
Forms of media:	Presentation, Whiteboard, Projector
Literature:	De Doncker, R. Lecture Notes Power Electronics Fundamentals, Topologies, Analysis Institut für Stromrichtertechnik und Elektrische Antriebe (ISEA), Aachen, 2011 ISBN 978-3-943496-00-0 Mohan, N., Undeland, T., Robbins, W. Power Electronics John Wiley, 2003, ISBN 0-471-42908-2 ***Further Readings:*** Mott, Robert L. Machine Elements in Mechanical Design Pearson Prentice Hall, 2004, ISBN 0-13-061885-3 Course materials from the lecturer Exercises from the lecturer

Module “Project I”

Module name:	Project I
Module code:	Mechanical Engineering: ME_17 Systems Engineering: SE_17 Industrial Engineering: IE_18 Electronics: EL_18
Courses (where applicable):	
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. P. Kisters Prof. Dr.-Ing. J. Gebel
Lecturer:	Depending on the project
Language:	English
Place in curriculum:	Core
Timetabled hours:	Project work: 4 HPW
Workload:	60 h attendance 120 h preparation and review
Credits:	6
Recommended prerequisites:	Specialised lectures in the respective courses, Course “Project Management”
Module objectives:	A team of students with 3-5 members (in exceptional cases individually) works on a solution to a given problem using what they have learned so far. They are able to organise the project independently and to put together well-defined work packages to work on in a defined time span. They comprehend the task and contribute purposefully and creatively to the solution. Students solve conflicts between team members independently. Students are able to professionally document the acquired results and to present them in a format suited to recipients.
Content:	Contents are course-specific
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	C. M. Anson and R. A. Schwegler, The Longman Handbook for Writers and Readers, fourth edition, Pearson Education Inc., 2005 Selected state-of-the-art papers Lecture materials and literature for specialised courses

Module “Business Economics”

Module name:	Business Economics
Module code:	Mechanical Engineering: ME_18 Mechatronic Systems Engineering: SE_18 Electronics: EL_19
Courses (where applicable):	- Investment, Financing and Controlling - Business Economics and Marketing
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	Prof. Dr. D. Berndsen
Language:	English
Place in curriculum:	Core
Timetabled hours:	Investment, Financing and Controlling: Lecture: 2 HPW Business Economics and Marketing: Lecture: 2 HPW
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	After finishing the module, students are able to bring forward arguments, using core terms of business economics. They can assess investment plans regarding advantageousness and know how to distinguish between different forms of financing. Students understand the influence of external factors on business decisions, in close coordination with the strategy and objectives of the organisation. They show an understanding of different legal structures of businesses and know how to assess them with regard to resources and objectives of the business. They gain an understanding of different business functions and practices and their effects on successful operation of a business. Furthermore, students have profound basic knowledge of marketing. They are able to classify and structure marketing issues and to make business decisions. They know and are able to apply methods and instruments for issues relevant to marketing.
Content:	The module covers basic questions and methods of

	business economics and operational areas of activity. For example, overlapping subjects relating to investment and finance decisions in the company will also be looked at in depth. It includes a basic introduction to marketing. In particular, the relationship between sales and marketing will be deepened. Furthermore, aspects of strategic and operational marketing are considered and specific marketing objectives are analysed. Essential methods and Instruments of marketing are conveyed.
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Investment, Financing and Controlling</u> Horváth, Peter: Controlling. 11th edition, Franz Vahlen, Munich, 2009 <u>Business Economics and Marketing</u> Dias, L.P./Shah, A. J.: Introduction to Business, Boston et al. 2009 Kotler, Ph.: Armstrong, G.; Wong, V.; Saunders, J.: Principles of Marketing. 5th European edition, Pearson Education, 2008 ***Further Readings:*** Schierenbeck, H.; Wöhle, C. B.: Grundzüge der Betriebswirtschaftslehre (Basics of Business Economics), 17th ed., Munich/Vienna 2008 Wöhe, G.: Einführung in die Allgemeine Betriebswirtschaftslehre (Introduction to General Business Economics), 24th ed., Munich 2010 Nickels, W. G.; McHugh, J.M.; McHugh, S.M.: Understanding Business, 8th ed., Boston et al. 2008 Madura, J.: Introduction to Business, 4th ed., Mason 2007 McLaney, E.; Atrill, P.: Accounting: An Introduction, 5th ed., Harlow et al. 2010 Pride, W.M.; Hughes, R.J.; Kapoor, J.R.: Introduction to Business, 11th ed., Australia et al. 2010 O´Sullivan; Sheffrin; Perez: Microenonomics - Principles, Applications, and Tools. 6th edition, Pearson Education, Inc. Publishing as Prentice Hall, 2010

Module “Modelling and Simulation”

Module name:	Modelling and Simulation
Module code:	Mechanical Engineering: ME_20 Mechatronic Systems Engineering: SE_19 Industrial Engineering: IE_21
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt
Lecturer:	Prof. Dr.-Ing. T. Brandt
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 2 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Mathematics and IT” Module “Applied Mathematics” Module “Statics and Electrical Engineering” Module “Elastostatics and Electronics” Module “Dynamics and Statistics”
Module objectives:	After successfully finishing the module, students are able to model and simulate dynamic multi-domain systems. The student should also be able to select suitable simulation methods for technical systems and to apply them practically. The student is furthermore able to identify steady states of a dynamic system and to linearize about them in order to create linear state space models. The student is familiar with basic numerical solution methods for differential and differential-algebraic equations. Furthermore, students should be able to interpret simulation results correctly and to estimate their accuracy after completing the module.
Content:	The course covers the fundamental methods of Modelling and Simulation of engineering systems (lecture) and applications (exercise) Contents in detail: • Definitions, general concepts

	• Methods of modelling of engineering systems • Introduction of differential and differential-algebraic equations • Identification of steady states • Linearization • Constraints of technical systems • Numerical methods for solving linear and non-linear state equations (initial value problems) • Identification of parameters • Application of MATLAB/Simulink
Assessment:	written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	F.E. Cellier: Continuous System Modeling, Springer Verlag, 1991 ***Further Readings:*** D. Möller: Modellbildung, Simulation und Identifikation Dynamischer Systeme (Modelling, Simulation and Identification of Dynamic Systems), Springer-Lehrbuch, 1992 R. Nollau: Modellierung und Simulation technischer Systeme: Eine praxisnahe Einführung (Modelling and simulation of technical Systems – A Practical Introduction), Springer Verlag, 2009, ISBN: 978-3540891208 M. Gipser: Systemdynamik und Simulation (System Dynamics and Simulation), Teubner Verlag, 1999, ISBN-13: 978-3519027430

Module “Measurement Engineering and Controls”

Module name:	Measurement Engineering and Controls
Module code:	Mechanical Engineering: ME_19 Mechatronic Systems Engineering: SE_20 Electronics: EL_21 Industrial Engineering: IE_22
Courses (where applicable):	
Semester:	4th semester
Module coordinator:	Prof. Nissing
Lecturer:	Prof. Nissing
Language:	English
Place in curriculum:	Core subject
Timetabled hours:	Lectures: 2 HPW Tutorials: 1 HPW Practicals: 1 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Mathematics and IT” Module “Applied Mathematics” Module “Dynamics and Statics” or “Alternating Currents and Mechanics”
Module objectives:	After finishing this module, students have fundamental knowledge and abilities for mathematical description and regulation of technical systems and are able to present these via block wiring diagrams. Furthermore, students are able to analyse and evaluate mathematically described time-continuous single-input/single-output (SISO) control systems. By doing this, a controller can be designed correspondingly meeting given requirements regarding stationary and dynamic behaviour. Additionally, students gain the ability to deduce requirements for the necessary measurement technique. The control engineering methods learnt this way will be deepened and attested by a tutorial as well as by laboratory work. Here, computer based development tools will be used, particularly Matlab/Simulink, so students are also able to cope with descriptions, calculations and

	analyses in a practice-oriented manner.
Content:	• Tasks, objectives and application of Measurement Engineering and Controls • Mathematical modelling of technical systems by means of differential equations • System description via block diagrams • Functionality and basic structure of control circuits • Characteristics of control systems - Linear and non-linear systems - Linearisation - Systems with concentrated/distributed parameters - Time-variant and time-invariant systems - Systems with deterministic or stochastic variables - Causal and non-causal systems • Description of linear continuous systems in the time domain - Step response - Impulse response - Convolution integral (Duhamels integral) • Description of linear continuous systems in the frequency range - Laplace transformation - Transfer functions - Frequency response representation - Locus representation - Bode-diagram • Dynamic and stationary behaviour of linear continuous control systems • Stability of linear continuous control systems - Definition of stability and stability condition - Hurwitz criterion/Routh criterion/Nyquist criterion • Design method for linear continuous control systems
Assessment:	laboratory, written examination
Forms of media:	Whiteboard, PowerPoint, Projector, Computer based Engineering Tools Matlab/Simulink
Literature:	Nise, Norman S.: Control Systems Engineering. 2011, John Wiley & Sons. ISBN 978-0-470-64612-0 Dorf, R. C., R.H. Bishop: Modern Control Systems. 2011, Pearson Education. ISBN 978-0-13-138310-4

Module “Mechatronics”

Module name:	Mechatronics
Module code:	Mechatronic Systems Engineering: SE_21
Courses (where applicable):	- Mechatronic Product Development - Sensors and Actuators - Bus Systems
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt
Lecturer:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. G. Gehnen
Language:	English
Place in curriculum:	Core
Timetabled hours:	Mechatronic Product Development: Lecture: 2 HPW Sensors and Actuators: Lecture: 1 HPW Exercise: 1 HPW Bus Systems: Lecture: 2 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Mathematics and IT” Module “Dynamics and Statistics” Module “Power Electronics and Drives”
Module objectives:	Students are familiar with the basic structure of mechatronic systems and their special requirements for the development and design process. The student knows the basic principles of mechatronic systems and is acquainted with the terms functional integration and hardware integration. They are able to solve technical issues in a functional and system oriented manner. Students are familiar with the basic elements of mechatronic systems and know examples for typical mechatronic solutions. In particular, students master the basic principles of different sensors and the further processing into data that is used in mechatronic systems. They are able to show the advantages of intelligent sensorics and to judge their

	application. They are able to compare different effects and select suitable sensors by examples for recording different physical variables. They are able to specify the requirements for actuators in mechatronics by means of modelling. Students master the basic concepts of bus systems. They are able to classify different methods of bit transmission via physical layers and distinguish the related methods of arbitration. Students are able to classify the advantages and disadvantages of different transmission methods and to select suitable bus systems for different cases of application. For this, they have knowledge of marketable bus systems for industrial application in mechatronics.
Content:	<u>Mechatronic Product Development</u> • Examples of mechatronic systems • Development methodology and design process in mechatronics • Development methodology according to VDI 2240 • Simulation in the development of mechatronic systems: Modelling and identification of parameters <u>Sensors and Actuators</u> • Basic principles of sensors • Processing of sensor data • Methods of temperature measurement • Measuring of forces and torques • Inductive sensor technologies • Capacitive sensor technologies • Classification and modelling of actuators • Piezo sensors and actuators <u>Bus Systems</u> • Basic structure of bus systems/communication interfaces • Terminology of information theory: entropy, redundancy, decision content • Ordinary channel models, channel capacity (Shannon, Nyquist model), influence of disturbances/noise • The ISO/OSI reference model • Physical bit transmission (NRZ/RZ signals, elementary bit coding) • Topologies (ring, star, bus...) • Arbitration process (CSMA-CD, CSMA-CA, TDMA, Token-Ring) • Methods for securing and checking data integrity • Statistical determination of bit error rates • Basic principles of analogue and digital modulation processes Sample systems for bus systems • USB • CAN

	• ProfiBus • Ethernet and TCP/IP/UDPPlacement of interfaces in the ISO/OSI reference model • Advantages and disadvantages of individual systems • Standardised SW interfaces towards hardware
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Mechatronic Product Development: R. Isermann: Mechatronic Systems: Fundamentals, Springer, 2005, ISBN: 978-1852339302 Sensors and Actuators: Sawomir Tumanski :Principles of Electrical Measurement (Series in Sensors), Inst of Physics Pub, 2006 Jörg Haus: Optical Sensors: Basics and Applications, Wiley-VCH, 2010 Bus Systems: Wilamowski Bodgan, Bodgan Wilamowski, J. David Irwin, Industrial Communication Systems (The Industrial Electronics Handbook), Crc Pr., 2011 ***Further Readings:*** W. Roddeck: Einführung in die Mechatronik (Introductory Mechatronics), Teubner, 1997, ISBN 3-51906357-3 Heimann, Gerth, Popp: Mechatronik: Komponenten – Methoden – Beispiele (Mechatronics: Components – Methods – Examples), Carl Hanser Verlag, 2006, ISBN: 978-3446405998 Jon Wilson: Sensor Technology Handbook, Newnes, 2004 Robert H. Bishop: The Mechatronics Handbook - Mechatronic Systems, Sensors and Actuators, CRC Press, 2008 Gerhard Schnell, Bernhard Wiedemann, Bussysteme in der Automatisierungs- und Prozesstechnik: Grundlagen, Systeme und Trends der industriellen Kommunikation, (Bus Systems in Automation and Process Engineering: Fundamentals, Systems and Trends of Industrial Communications) Vieweg & Teubner, 2008 Friedrich Wittgruber, Digitale Schnittstellen und Bussysteme. Einführung für das technische Studium

	(Studium Technik) (Digital Interfaces and Bus Systems – Introduction to Engineering Studies), Vieweg, 2002 Richard Zurawski, The Industrial Communication Technology Handbook (The Industrial Information Technology Series), Crc Pr., 2005 Course materials from the lecturer

Module “Object Oriented Software Development”

Module name:	Object Oriented Software Development
Module code:	Mechatronic Systems Engineering: SE_22 Electronics: EL_22
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr. M. Krauledat
Lecturer:	Prof. Dr. M. Krauledat
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Practicals: 2 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “IT-Programming”
Module objectives:	After successfully finishing the module, students are able to • develop small programs with object-oriented design • analyze program code that has been created in an object-oriented manner • transfer technical problems into an object-oriented design and to describe them in UML
Content:	Programming • Introductory Programming • Introduction to the concept of object-oriented programming • Program development tools • Control flow and control structures • Pointer and references • Functions in OOP • Classes • Interfaces • Inheritance • Polymorphism • Abstract data types(ADT) • Enumerations and Collections • Input, output and streams • Name ranges and visibility

	• Object-oriented analysis • Object-oriented design, UML • Design Patterns • Treatment of errors and exceptions • Examples and practical programming exercises by means of a concrete object-oriented programming language (such as: C++, JAVA)
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector, Flip-Chart
Literature:	D. Flanagan : Java in a Nutshell: A Desktop Quick Reference, O'Reilly, 2005, ISBN: 978-0596007737 S. Oualline: Practical C++ Programming, O'Reilly, 2003, ISBN: 978-0596004194 D. Boles, C. Boles: Objektorientierte Programmierung spielend gelernt, Vieweg&Teubner, 2. Auflage, 2010

Module “Controls”

Module name:	Controls
Module code:	Mechatronic Systems Engineering: SE_23 Electronics: EL_23
Courses (where applicable):	- Controls - Microelectronic Control Systems
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. D. Nissing
Lecturer:	Prof. Dr.-Ing. D. Nissing Prof. Dr.-Ing. I. Volosyak
Language:	English
Place in curriculum:	Core
Timetabled hours:	<u>Controls:</u> Lecture: 2 HPW Exercise: 1 HPW Practicals: 1 HPW <u>Microelectronic Control Systems:</u> Lecture: 1 HPW Practicals: 1 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Measurement Engineering and Controls” Module “Modelling and Simulation”
Module objectives:	<u>Controls</u> After finishing the module, students have the knowledge and ability to design, analyse and evaluate a discrete-time controller. For this, the knowledge gained in the module “Measurement Engineering and Controls” is used and expanded by additional processes and methods. Students will, for example, be able to display control systems in state space. Furthermore, students gain the necessary skills to design and to parameterise linear observers for determining non-measurable properties or those that can only be determined by very elaborate methods. Identifying corresponding structural measures such as controllability and observability are also a part of this. Additionally, students are able to implement the designed controllers

	into digital control systems which contain programmable logic controllers, too. Apart from -discrete-time controllers, dimensioning and definition of control systems are also a part of this. The methods learned this way will be deepened and attested by tutorial as well as by laboratory work. Here, computer based development tools will be used, particularly Matlab/Simulink and Siemens Step7, so students are also able to cope with descriptions, calculations and analyses in a practice-oriented manner. <u>Microelectronic Control Systems</u> After completing this module, students are able to design the architecture of microelectronic controls. They are able to select corresponding components and to evaluate them for application. They master the essential aspects of safety-oriented control systems in hardware and software and are able to interpret them corresponding to relevant principles. Students are familiar with key technologies for realising modern control systems such as networks, real time systems and modern interactive interfaces. They are able to create analyses of the expected requirements and to select corresponding systems.
Content:	<u>Controls</u> • Tasks, objectives and application of controls • State space representation - Single-variable systems - Multi-variable systems - Normal forms in state space representation - Controllability and observability - Synthesis of linear control systems in state space • Reconstruction of state via observer • Linear time-discrete systems (digital controlling) - Functioning of digital control systems - z-transformation • Programmable logic controllers (PLC) - Hardware and components - Fundamentals of logic - Flip-flops - PLC programming (ladder diagram, instruction list, functional block diagram, flowchart) - Karnaugh-Veitch (KV)-Diagram - Programming timers and counters <u>Microelectronic Control Systems</u> • Architecture of control systems • Components of microelectronic controls • Security aspects in designing control systems • Safety-oriented programming • Safety-oriented hardware

	• Object-oriented programming in Automation engineering • Distributed controls • The concept of real time • Graphical user interface
Assessment:	Controls: written examination Microelectronic control systems: Attestation within the scope of laboratory,
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Nise, Norman S.: Control Systems Engineering. 2011, John Wiley & Sons. ISBN 978-0-470-64612-0 Petruzella, Frank D.: Programmable Logic Controllers. 2011, McGraw-Hill. ISBN 978-0-07-351088-0

Module “Robotics and Assistance Systems”

Module name:	Robotics and Assistance Systems
Module code:	Mechatronic Systems Engineering: SE_24
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt
Lecturer:	Prof. Dr.-Ing. T. Brandt
Language:	English
Place in curriculum:	Core
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW Practicals: 1 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Dynamics and Statistics” Module “Modelling and Simulation” Module “Measurement Engineering and Controls” Module “Power Electronics and Drives”
Module objectives:	Students know mathematical methods for describing position and orientation of robots. They are able to create direct and inverse kinematic and dynamic models of a robot and to simulate corresponding robot motions. They are able to plan complex robot motions and to realize the planned trajectories. Students are particularly aware of different kinds of Human-Machine-Interaction and are able to define the technical components of assistance systems.
Content:	• Description of position and orientation (vectors, angles, matrices, Euler angles) • Kinematics of serial robots (Denavit-Hartenberg-convention, ambiguities, singularities, inverse kinematics), position, speed and acceleration of serial manipulators • Dynamics of robots • Design of robot trajectories • Axis controls • Force-based controls • Human-Machine-Interaction (Haptic communication, visual communication) • Applications

Assessment:	Written examination or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Mark W. Spong; Seth Hutchinson; Mathukumalli Vidyasagar: Robot Modeling and Control, Wiley & Sons, 2006, ISBN: 978-0471649908 John J. Craig: Introduction to Robotics: Mechanics and Control, Pearson Education, 3rd edition, 2009, ISBN-10: 8131718360

Module “Innovation and Entrepreneurship”

Module name:	Innovation and Entrepreneurship
Module code:	Mechanical Engineering: ME_25 Mechatronic Systems Engineering: SE_25 Electronics: EL_24
Courses (where applicable):	- Innovation Management - Entrepreneurship
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	Prof. Dr.-Ing. D. Untiedt
Language:	English
Place in curriculum:	Core
Timetabled hours:	Innovation Management: Lecture: 2 HPW Entrepreneurship: Lecture: 1 HPW Practicals: 1 HPW
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Business Economics”
Module objectives:	In most cases, founding a business is based on innovative business concepts. This module combines the skills for strategic business planning and founding with knowledge of innovation management and technology. Students learn the fundamentals of innovation and technology management. They are able to purpose fully apply suitable methods and instruments of innovation management in daily operations. For this, a clear understanding of the innovation process, its success factors and its management and controlling instruments will be conveyed. After finishing the module, students should be able to create technology portfolios and to use roadmaps. Furthermore, they should have fundamental knowledge in the area of projections and scenarios. They are able to evaluate technological innovations particularly with regard to opportunities and risks. The entrepreneurial thinking and behaviour of the student will be specifically trained with regard to essential skills for establishing a business. After completing the module, students are able to analyse and

	evaluate markets, market performance, customer value and competitive advantages. They have fundamental knowledge of creating business plans that are always built around the business concept. They learn to apply individual management methods and instruments for decision-making.
Content:	<u>In particular, this module in the sector Innovation Management contains the following subjects:</u> • Fundamentals of Innovation Management • Strategic Innovation Management • Product Planning • Product architectures • Product development processes • Innovation controlling • Product lifecycle management <u>Core contents of the subject entrepreneurship are:</u> • Theoretical basis • Legal forms • Business plan creation The theoretical knowledge gained in the sector of entrepreneurship will be simulated and deepened by an IT-based business game.
Assessment:	Innovation Management: Attestation Entrepreneurship: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector, Business game
Literature:	Trott, P.: Innovation Management and new product development. 4th edition. Pearson Education Ltd., 2008 Barringer, B. R.; Ireland, R. D.: Entrepreneurship – successfully launching new ventures. 3rd edition, Pearson, 2010 ***Further Readings:*** Schuh, G.(Hrsg.): Innovationsmanagement. In: Handbuch Produktion und Management 3. Zweite Auflage, Springer, 2012 Mariotti, St.; Glackin, C.: Entrepreneurship & small business management. Pearson, 2012

Module “Project II”

Module name:	Project II
Module code:	Mechanical Engineering: ME_26 Mechatronic Systems Engineering: SE_26 Industrial Engineering: IE_26 Electronics: EL_26
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	Depending on the project
Language:	English
Place in curriculum:	Core
Timetabled hours:	Project work: 4 HPW
Workload:	60 h attendance 120 h preparation and review
Credits:	6
Recommended prerequisites:	Module “Project I”, Module “Business Economics” specialised lectures
Module objectives:	Students work on solutions for a given task in teams (in exceptional cases individually). For this, students create a functional specifications document and calculate project costs and necessary capacities. They present their self-designed concepts to their clients and are able to defend these concepts. Students react constructively to suggestions and criticism and further develop their approaches into a marketable product. They determine implementation and product costs and are able to estimate market potentials. Students contact suppliers and decide on purchase of material and components. Apart from content-related processing, students also master documenting and presenting the results and thereby interact with potential customers.
Content:	Contents are course-specific
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	C. M. Anson and R. A. Schwegler, The Longman

	Handbook for Writers and Readers, fourth edition, Pearson Education Inc., 2005 Selected state-of-the-art papers

Module “Mobile Hydraulics”

Module name:	Mobile Hydraulics
Module code:	Mechatronic Systems Engineering: SE_27.1
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. R. Schmetz
Lecturer:	Prof. Dr.-Ing. R. Schmetz
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW
Workload:	45 h attendance 45 h preparation and review 30 h exam preparation
Credits:	4
Recommended prerequisites:	Course “Fundamentals of Physics” Course “Elastostatics” Course “Dynamics” Module “Mathematics and IT” Module “Statics and Electrical Engineering” Module ”Technical Drawing” Module “Applied Mathematics” Module “Power Electronics and Drives”
Module objectives:	After finishing the module, students are able to • understand the principles of mobile hydraulic systems and to compare them with mechanical, pneumatic, mechatronic and electrical systems • to describe typical applications of mobile hydraulics and to explain their advantages and disadvantages • assign the functions to typical mobile hydraulic components, arrange them in a mobile hydraulic circuit diagram and conduct simple calculations
Content:	Fundamentals of hydraulics, typical applications, advantages and disadvantages, definitions and contexts Mobile hydraulic components: Pumps, cylinders, motors, valves, orifices, fluids, accumulators, filters, containers and sensors

	Mobile hydraulic drives and suspension systems Mobile hydraulic controls
Assessment:	Written or oral examination
Forms of media:	Presentation, Whiteboard, Projector
Literature:	Course materials from the lecturer Exercises from the lecturer ***Further Readings:*** Project-Manual “Industrial Hydraulics” Publisher: Bosch-Rexroth AG, 2007, Order No. R961003751 Project-Manual “Mobile Hydraulics - Throttle Control” Publisher: Bosch-Rexroth AG, 2011, Order No. R961005093 Project-Manual “Mobile Hydraulics - Load Sensing Control” Publisher: Bosch-Rexroth AG, 2011, Order No. R961005146 Project-Manual “Mobile Hydraulics - LUDV” Publisher: Bosch-Rexroth AG, 2011, Order No. R961005148

Module “Agricultural Engineering”

Module name:	Agricultural Engineering
Module code:	Mechatronic Systems Engineering: SE_27.2
Courses (where applicable):	Agricultural Engineering
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. R. Schmetz
Lecturer:	Prof. Dr.-Ing. R. Schmetz
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 2 HPW
Workload:	30 h attendance 15 h preparation and review 15 h exam preparation
Credits:	2
Recommended prerequisites:	Course “Fundamentals of Physics” Course “Elasto-Statics” Course “Dynamics” Module “Mathematics and IT” Module ”Technical Drawing” Module “Applied Mathematics” Module “Technical Design” Module “Power Electronics and Drives”
Module objectives:	After finishing the module, students are able to • explain the objectives and tasks of the technology of agricultural machines, • describe the main functions and assemblies of the most important agricultural machines, • conduct simple calculations at assemblies, • calculate mass flows in and productivity of agricultural machines, • make decisions regarding the selection of agricultural machines and the application of agricultural machines for different machining tasks, • recognise weak spots in agricultural machines and to propose improvements.
Content:	The various agricultural machines are dealt with according to the seasonal workflow in agriculture in the following sections:

	Objectives and tasks of technology of agricultural machines, basic definitions and contexts Cultivation machines Sowers and planters Fertilizers and machines for pest-control Machines for the harvest of hay and silage Self-propelled forage harvesters Combine harvesters Terramechanics Tractors Precision farming
Assessment:	Written or oral examination
Forms of media:	Presentation, Whiteboard, Projector
Literature:	CIGR Handbook of Agricultural Engineering, Volume III Plant Production Engineering, 1st edition 1990, ISBN 1-892769-02-6, Publisher: American Society of Agricultural and Biological Engineers, St.Joseph, MI 49085-9659, USA Srivastava, A., Goering; C., Rohrbach, R., Buckmaster, D.. Engineering Principles of Agricultural Machines, 2nd edition 2006, ISBN 1-892769-50-6, Publisher: American Society of Agricultural and Biological Engineers, St.Joseph, MI 49085-9659, USA Course materials from the lecturer Exercises from the lecturer

Module “Vehicle Technology”

Module name:	Vehicle Technology
Module code:	Mechatronic Systems Engineering: SE_27.3
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. D. Nissing
Lecturer:	Prof. Dr.-Ing. D. Nissing
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW
Workload:	45 h attendance 45 h preparation and review 30 h exam preparation
Credits:	4
Recommended prerequisites:	Module “Measurement Engineering and Controls” Module “Dynamics and Statistics” Module “Modelling and Simulation”
Module objectives:	After completing this Elective, students have knowledge of essential systems and components in vehicles. They are able to describe mathematically the characteristics of components and are able to integrate and analyse these in the overall context for the corresponding tasks of distinguishing features and typical characteristics for vehicles. The knowledge and methods from the modules “Measurement Engineering and Controls”, “Dynamics and Statistics” and “Modelling and Simulation” will be applied to vehicle technology. After completing this course, students have gained the ability to describe vehicle dynamics in all six coordinates (longitudinal, lateral, vertical, pitch, roll and yaw behavior) and have the knowledge as to which components and systems characterise the respective behaviour and how to influence the dynamic behaviour, such as over and under-steering by ESP. The gained knowledge will be deepened by practical Exercise. Here, computer based development tools are used, especially Matlab/Simulink, so students are also able to describe, calculate and analyse the different systems and features in a practical way.
Content:	• Overview - Terminology

	- Control loop driver – vehicle – environment - Active and passive safety - Coordinate systems • Requirements of driving dynamics of vehicles • Suspension kinematics • Chassis systems and components (tire, axles and suspensions, spring-damper elements) • Vertical dynamics • Longitudinal dynamics - Driving resistances - Braking • Lateral dynamics - Steering kinematics - Single-track (bicycle) model - Self-steering: over/under-steering - Multi-track model • Vehicle control systems - ABS/ESP - Semi-active damper - Overlay of steering moments, steering angles - Active suspensions • Driver assist functions
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector, Computer based Engineering Tools MATLAB/Simulink
Literature:	George Rill: Road Vehicle Dynamics. CRC Press. 2012. ISBN 978-1-4398-3898-3. Bernd Heißing, Metin Ersoy: Chassis Handbook. Vieweg. 2011. ISBN 978-3-8348-0994-0. ***Further Readings:*** Giancarlo Genta: Motor Vehicle Dynamics. World Scientific. 2008. ISBN 978-981-02-2911-5. Reza N. Jazar: Vehicle Dynamics. Springer. 2008. ISBN 978-0-387-74243-4. H.-H. Braess, U. Seiffert: Vieweg Handbuch der Kraftfahrzeugtechnik (Handbook of Motor Vehicle Engineering). Vieweg. 2007. ISBN 978-3-8348-0222-4.

Module “Multibody Dynamics”

Module name:	Multibody Dynamics
Module code:	Mechanical Engineering: ME_27.8 Mechatronic Systems Engineering: SE_27.4
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt
Lecturer:	Prof. Dr.-Ing. T. Brandt
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 2 HPW Practicals: 2 HPW
Workload:	60 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Mathematics and IT” Module “Applied Mathematics” Module “Statics and Electrical Engineering” Module “Elastostatics and Electronics” Module “Dynamics and Statistics” Module “Modelling and Simulation”
Module objectives:	After successfully finishing the module, students are familiar with the fundamentals of multibody dynamics. They are able to apply basic concepts from linear algebra such as vectors and matrices to mechanical systems. The kinematics of technical joints such as revolute joints can be modelled by algebraic constraints by the student. The student is also able to model the dynamics of constraint multibody dynamic systems based on the method of Newton-Euler. Furthermore, the student is able to develop basic programming code in order to simulate planar multibody dynamic systems and to perform analysis of planar multibody dynamic systems.
Content:	The course focuses on the modelling and numerical simulation of dynamic multibody systems. Main subjects are: • Definitions: bodies, joints, and coordinates • Planar kinematics: rotation, translation

	• Kinematic constraints • Dynamics: Newton-Euler equations • Development of multibody dynamics simulation code • Analysis of multibody dynamic systems
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	P. E. Nikravesh: Planar Multibody Dynamics - Formulation, Programming, and Application, CRC press,2008

Module “Control of Plants in Process Engineering”

Module name:	Control of Plants in Process Engineering
Module code:	Mechatronic Systems Engineering: SE_27.5
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	External Lecturer
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Exercise: 1 HPW
Workload:	30 h attendance 15 h preparation and review 15 h exam preparation
Credits:	2
Recommended prerequisites:	Module “Measurement Engineering and Controls” Module “Thermodynamics” Module “Fundamentals of Process Engineering”
Module objectives:	After completing this Elective, students have knowledge of controls for plants in process engineering. Students are able to compare and evaluate the interplay of the knowledge already gained in the modules “Measurement Engineering and Controls”, “Thermodynamics” and “Fundamentals of Process Engineering”. Students gain knowledge of advanced control methods (for instance, cascade control, feedforward control, disturbance compensation, etc.) that are widely applied in industrial plants. In particular, students learn also the methodology of model predictive control. They are able to apply the necessary control methods for different cases of application. Furthermore, students know the main features of field devices in plants and distributed control systems. They understand the background and know the basic idea of control performance monitoring, alarm monitoring and plant asset management, which are currently receiving much attention in the process industry. The gained knowledge will be deepened by practical Exercise. Here, computer based development tools such as MATLAB/Simulink will be used.

Content:	• Overview - Terminology: feedback control, logic control, etc. - Representative processes - Typical control problems in plants - Automation pyramid • Field devices - Sensors - Actuators • Advanced control schemes - Two point control - Three point control - Ratio control - Split range control - Cascade control - Feedforward control - Disturbance compensation - Smith predictor - Internal model control • Model predictive control • Batch control • Distributed control systems • Process information and management systems • Control performance monitoring • Alarm management • Process monitoring • Plant asset management
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector, Computer based Engineering Tools MATLAB/Simulink
Literature:	D. E. Seborg et al. Process Dynamics and Control. Wiley. 2011. K. F. Früh et al. Handbuch der Prozessautomatisierung (Handbook of Process Automation). Oldenbourg Industrieverlag, 2009. ***Further Readings:*** B. Wayne Bequette. Process Control – Modeling, Design and Simulation. Prentice Hall, 2003. J. P. Corriou. Process Control – Theory and Applications. Springer, 2004. Course materials from the lecturer

Module “Special Sensors and Actuators”

Module name:	Special Sensors and Actuators
Module code:	Mechatronic Systems Engineering: SE_27.6
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr. A. Struck
Lecturer:	Prof. Dr. A. Struck
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lectures: 2 HPW
Workload:	30 h attendance 15 h preparation and review 15 h exam preparation
Credits:	2
Recommended prerequisites:	Course “Sensors and Actuators”
Module objectives:	By the range of knowledge gained in the Course Sensor technology and Actuator Engineering, students will know further special sensor technologies and actuator engineering as well as their application. They are able to describe special magnetic and electrical effects and to design sensor systems based on effects. They recognise advantages resulting from the connection of sensors in the sense of a data fusion and are able to compose corresponding combinations. In the area of actuator engineering, students know special actuators based on controlled changes of material characteristics and their practical application. They master the principle of self-sensing and are able to create mechatronic solutions by corresponding modelling.
Content:	Non-destructive testing with magnetic means Determination of speed and position with micromechanical sensors and actuators Kalman filter Artificial nose Sensor data fusion Time domain spectroscopy with terahertz radiation Electrorheological actuators

	Magnetostriction and application as sensor and actuator Shape memory alloys Self-sensing principle – Modelling and evaluation
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Robert H. Bishop: The Mechatronics Handbook – Mechatronic Systems, Sensors and Actuators, CRC Press, 2008 Dan Simon: Optimal State Estimation: Kalman, H Infinity, and Nonlinear Approaches, John Wiley & Sons, 2006 ***Further Readings:*** Hartmut Janocha: Unkonventionelle Aktoren: Eine Einführung (Unconventional Actuators: An Introduction), Oldenbourg Wissenschaftsverlag, 2010 Horst Czichos: Mechatronik: Fundamentals und Anwendungen technischer Systeme (Mechatronics: Fundamentals and Applications of technical Systems), Vieweg und Teubner, 2008 Falko Dressler: Self-Organization in Sensor and Actor Networks, John Wiley & Sons, 2007 Paul Gümpel: Formgedächtnislegierungen: Einsatzmöglichkeiten in Maschinenbau, Medizintechnik und Aktuatorik (Smart Metals: Application possibilities in Engineering, Medical Engineering and Actuatorics, Expert Verlag, 2004 Course materials from the lecturer

Module “Optical Systems in Mechatronics”

Module name:	Optical Systems in Mechatronics
Module code:	Mechatronic Systems Engineering: SE_27.7
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr. G. Bastian
Lecturer:	Prof. Dr. G. Bastian
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW Practicals: 1 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Mechatronics” Module “Measurement Engineering and Controls”
Module objectives:	Students have a general view of optical systems and interaction of optical components. They are able to understand and classify the function of such apparatus as optical microscopes and data storage devices, together with measuring techniques, lithography and laser machining. Students master the design of optical systems with simple examples learnt with numerical aids.
Content:	Aside from fundamentals of propagation of light, refraction and diffraction as well as spectroscopy, the peculiarities and concepts of practical optical systems are discussed and demonstrated by various examples.
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	“Optics”, E. Hecht (Addison Wesley), 2003, ISBN 0805385663 “Introduction to Modern Optics”, G. R. Fowles (Dover Publications) ISBN 0486659577

Module „Finite Elemente Analysis“

Module name:	Finite Element Analysis
Module code:	Mechanical Engineering: ME_27.5 Mechatronic Systems Engineering: SE_27.8
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. H. Schütte
Lecturer:	Prof. Dr.-Ing. H. Schütte
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 2 HPW Practicals: 2 HPW
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	Course “Statics” Course “Elastostatics” Module “Applied Mathematics” Module “Modelling and Simulation”
Module objectives:	The students are able to decide when and if it is advisable to use the Finite Element Method as the proper numerical tool. They know the theoretical background of the method and are able to build up FEM simulation models. They are able to introduce engineering modelling simplifications to balance effort and accuracy. Using their mechanical and physical background knowledge they can define material properties, boundary conditions and interpret solution results. They can evaluate the proper quality of an FEM discretization (mesh). They know how to approach geometrically and material non-linearities of the models. The interpret results with respect to their accuracy and if these are suitable for the design purpose of the simulation. The students are able to undertake their own analysis and write the corresponding reports and can discuss the results based on presentations.
Content:	• Idea of FEM • Impact on and position of FEM in the engineering design process

	• Comparison of advantages and disadvantages of analytical, numerical and especially FEM solutions • Different element types and shape functions • Element types for different physical processes (mechanical, thermal, electrical, magnetic, combined) • Element and mesh quality • Material models • Different solvers and their algorithms • Differences between linear and non-linear models • Examples of non-linear simulations • Simulating contact • Buckling analysis • Modal analysis • Transient dynamic analysis • Simplifications: using symmetries and sub modelling • Writing reports on calculations and present them • Critical analysis of simulation results • Limitations of FEM Calculations
Assessment:	written or oral examination
Forms of media:	whiteboard, PowerPoint, Projector, ANSYS Workbench
Literature:	H. Lee: Finite Element Simulations With ANSYS Workbench 14, SDC Publication, 2012 Daryl L. Logan: A First Course in the Finite Element Method, 5th Edition, ISBN 978-0-495-66827, Cengage Learning, 2011 ***Further Readings:*** Nam-Ho Kim, Bhavani V. Sankar: Introduction to Finite Element Analysis and Design, ISBN 978-0-470-12539, Wiley and Sons, 2009 Erdogan Madenci, Ibrahim Guven: The Finite Element Method and Applications in Engineering Using ANSYS, Corrected and 4th printing, ISBN 978-0-387-28289-3, Springer, 2007

Module „Internship“

Module name:	Internship
Module code:	Mechanical Engineering ME_28 Mechatronic Systems Engineering SE_28 Industrial Engineering IE_28 Electronics EL_28
Courses (where applicable):	
Semester:	6th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	Supervisor of the internship
Language:	English
Place in curriculum	Core
Timetabled hours:	none
Workload:	900 h
Credits:	30
Recommended prerequisites:	Min. 89 CP from the curriculum
Module objectives:	Students work in one or more functional units of an enterprise. They support or carry out engineering-based activities, applying their previously acquired knowledge and methods. The students should also recognize interdependencies between economic, environmental, ethical and safety aspects and learn to handle them. The internship can be completed abroad.
Content:	The contents of the internship are based on the business activities and the business environment of the company. They are closely coordinated between the company and the university, so that a consistent professional tie is guaranteed to the study.
Assessment:	Internship report

Module „Workshop Thesis“

Module name:	Workshop Thesis
Module code	Mechanical Engineering ME_29 Mechatronic Systems Engineering SE_29 Industrial Engineering IE_29 Mechanical Engineering EL_29
Courses (where applicable):	
Semester:	7th Semester
Module Coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	External Lecturers
Language:	English
Part of Curriculum	Core
Timetable hours	Seminar
Workload	180 h
Credits:	6
Recommended prerequisites::	
Module objectives:	The students learn the content and formal design of scientific work. In addition, they are able to present their results. The specific situation of the students in advance of a final thesis is particularly taken into account. Thus, with the students answers to the following questions are developed: • How do I find a topic? • What are the basics of scientific work? • How to set up a research paper? • How do I use language? • How to schedule the scientific thesis?
Content:	• The way to write a scientific paper • Form and format • Structure: Depth, Transition, and Emphasis • Scientific Work and Research • Quotation • Use of language • Scientific Illustration • Scientific Presentation • Using word-processing programs • Handling Special Stituations

Assessment:	Attestation
Forms of media:	Whiteboard, Power Point
Literature:	Alley, M.: The Craft of Scientific Writing. 3rd ed., Springer, 1996 Karmasin, M.; Ribing, R.: Die Gestaltung wissenschaftlicher Arbeiten: Ein Leitfaden für Seminararbeiten, Bachelor-, Master- und Magisterarbeiten sowie Dissertationen. 7th ed., UTB, 2012.

Module „Workshop Scientific methods“

Module name:	Workshop Scientific Methods
Module code	Mechanical Engineering ME_30 Mechatronic Systems Engineering SE_30 Industrial Engineering IE_30 Electronics EL_30
Courses (where applicable):	
Semester:	7th Semester
Module Coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	External lectures
Language:	English
Part of Curriculum	Core
Timetable hours	Seminar
Workload	180 h
Credits:	6
Recommended prerequisites::	
Module objectives:	The course offers an introduction to the ethics and logic of science as well as to some methods helpful for the investigation of technical questions. Beside methodological aspects the students understand their ethic responsibility as a scientist and reflect their work based on social impacts and scientific rules. The students know scientific misconduct like fabrication, falsification, copyright violation, wrong citation, plagiarism, violation of ethical standards etc. The students are able to get a full overview over their topic and use literature research for this. They repeat the basic principles of scientific procedure and are able to practically implement their knowledge on a scientific question. They are aware of the differences between theory and empiricism as well as between deductive and inductive reasoning. The students reflect their work accordingly. In case experimental validations of phenomena are required they are able to structure their test program using design of experiments. The students evaluate the limits for testing, they define and rate the required simplifications. Research results are analysed statistically and reflected critically in order to evaluate the quality of the results. Finally the students prepare the results specific to a target groups.

Content:	Methodological principles encompass the entire process of the scientific questioning • Science ethics - what is allowed - what shall remain unexplored • Ethical standards in science • Social impacts of science • Analysis of the scientific question • Literature research • Definition state of the art • Introduction to the logic of science • Inductive vs. deductive reasoning • Formulation of hypotheses • Verification and falsification of hypotheses • Degree of testability • Simplification and probability • Design of experiments • Numerical and graphical data analysis • Descriptive and analytical statistics • Presentation of data / results • Publication of the results in different forms (report, paper, poster, web pages etc.)
Assessment:	Attestation
Forms of media:	Board, Power Point
Literature:	Karl R. Popper: The Logic of Scientific Discovery, ISBN 978-0415278447, reprint 2004, Taylor & Francis Douglas Montgomery, George Runger: Applied Statistics and Probability for Engineers. SI Version. 5th edition, Wiley, 2011 ***Further Readings:*** Geoffrey Vining, Scott Kowalski: Statistical Methods for Engineers. 3rd edition. Brooks/Cole, 2011 Douglas Montgomery: Introduction to Statistical Quality Control. 5th edition. Wiley, 2005

Module „Bachelor Thesis“

Module name:	Bachelor Thesis
Module code:	Mechanical Engineering ME_31 Mechatronic Systems Engineering SE_31 Industrial Engineering IE_31 Electronics EL_31
Courses (where applicable):	
Semester:	7th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	Project dependent
Language:	English
Place in curriculum	Core
Timetabled hours:	none
Workload:	360 h
Credits:	12
Recommended prerequisites:	Min. 175 credit points in the respective courses
Module objectives:	The students - demonstrate their capability to work independently on a subject in alignment with their course of studies, meeting all topical and scientific requirements in a limited period of time - are able to organize their workflow in order to meet the demands of the problems formulated in their theses, as well as to monitor progress and make necessary amendments - are able to document their approach and their results to meet the requirements of a scientific publication
Content:	Thesis content depends on the chosen topic and is agreed upon with the supervisor. Documentation is granted by an adequately sized description of the topic/problem, the chosen approach, used methods and results.
Assessment:	Written Thesis in the range of 50–100 DIN A4 pages
Medienformen:	Written Thesis
Literatur:	C. M. Anson and R. A. Schwegler, The Longman Handbook for Writers and Readers, fourth edition, Pearson Education Inc., 2005 Selected state-of-the-art papers

	Lecture materials and literature for specialised courses

Module „Colloquium“

Module name:	Colloquium
Module code:	Mechanical Engineering ME_32 Mechatronic Systems Engineering SE_32 Industrial Engineering IE_32 Electronics EL_32
Courses (where applicable):	
Semester:	7th Semester
Module coordinator:	Prof. Dr.-Ing. T. Brandt Prof. Dr.-Ing. H. Schütte
Lecturer:	Supervisor of the Bachelor Thesis
Language:	English
Place in curriculum	Core
Timetabled hours:	none
Workload:	90 h
Credits:	3
Recommended prerequisites:	Min. 207 Credits
Module objectives:	The students • are able to defend the results of the Bachelor Thesis • place their work in a context of practical applications and present their results in a proper form for the audience. They motivate their approach and make estimations, how assumptions and simplifications may affect the validity of their results • are able to analyze questions concerning their thesis and results and answer them properly in the context of professional and extra-professional reference
Content:	Content is aligned with the content of the Bachelor Thesis, in addition methodological discussions
Assessment:	Oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	M. Powell, Presenting in English – how to give successful presentations, Heinle Cengage Learning, 2011 S. Krantman, The Resume Writer’s Workbook, fourth edition, South-Western Cengage Learning, 2013