Faculty of Technology and Bionics

HOCHSCHULE RHEIN-WAAL
Rhine-Waal University of Applied Sciences

Module Description

of the study course

„Electronics B.Sc.“

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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. 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, Prof. Dr.-Ing. P. Zhang
Language:	English
Place in curriculum:	Core
Timetabled hours:	Introductory Mathematics: Lecture: 2 HPW Exercise: 2 HPW Computer-based Engineering Tools: Computer Labs: 2 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	Introductory Mathematics: 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. <u>Computer based Engineering Tools:</u> 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:	<u>Introductory Mathematics:</u> • 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 <u>Computer based Engineering Tools:</u> • 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 "Fundamentals of Electronics and Mechanics"

Module name:	Fundamentals of Electronics and Mechanics
Module code:	Electronics EL_3
Courses (where applicable):	- Direct Current and Net Analysis - Statics - Electrical Engineering Laboratory
Semester:	1st Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	Prof. Dr.-Ing. H. Schütte Prof. Dr.-Ing. G. Gehnen
Language:	English
Place in curriculum:	Core
Timetabled hours:	Direct Current and Net Analysis: Lecture: 2 HPW Exercise: 1 HPW Statics: Lecture: 2 HPW Exercise: 1 HPW Electrical Engineering Laboratory: Practicals: 1 HPW
Workload:	105 h attendance 20 h preparation and review 25 h exam preparation
Credits:	5
Recommended prerequisites:	School knowledge in Physics and Mathematics
Module objectives:	<u>Direct Current and Net Analysis/Electrical Engineering laboratory:</u> 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 potential differences in these networks. They are able to calculate transient processes with capacitors and inductances by means of ordinary differential equations. They can analyse a static electric field as a vector field, and can calculate the electrical potential as a property of the vector field. They are able to analyse simple electric flow fields and to calculate resistances from first principles.

	Students are able to apply and validate the learned methods using simulations. The learnt abilities are trained and tested in an accompanying exercise and in the lab. <u>Statics:</u> 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.
Content:	<u>Direct Current and Net Analysis/Electrical Engineering laboratory:</u> • General introduction to Electrical Engineering, historical background • Electrostatics: atoms, electrons and charge • Coulomb‘s law • Current as charge movement • Electric potential and voltage • Resistors, Ohm’s law • Electrical safety • Resistors in parallel and series • Kirchhoff’s laws • Mesh Analysis • Electric power and energy • Superposition principle • Thevenin’s theorem, equivalent sources • Fundamentals of capacitors • Transient processes in capacitors • Induction • Inductors and their analogy to capacitors • Transient processes in inductors • Circuit simulation with SPICE • Stationary electrical flow fields <u>Statics:</u> 1. Fundamentals 1.1 Definition of force as vector 1.2 Newtonian laws 1.3 Rigid body 1.4 Method of sections

	2. Forces with a common point of origin 2.1 Vector summation of forces in a plane 2.2 Decomposition of forces in a plane 2.3 Equilibria in a plane 3. Force systems and equilibrium in the rigid body 3.1 Forces in the plane and in space 3.2 Torque vector 4. Centroids 4.1 Centroid and centre of mass of a body 4.2 Centroid of an area 4.3 Centroid of a line 5. Load bearing structures 5.1 Planar structures 5.2 Spatial structures 5.3 Multi-element structures 6. Trusses 6.1 Static specification 6.2 Design of a truss 6.3 Determining forces in the members 7. Beams, frames and arcs 7.1 Internal forces in a straight beam 7.2 Internal forces in frames and arcs
Assessment:	Statics, Direct Current and Net Analysis: written examination Electrical Laboratory: attestation
Forms of media:	Whiteboard, PowerPoint, Projector, Simulation programs, laboratory equipment
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>Direct Current and Net Analysis/Electrical Engineering laboratory:</u> R.L. Boylestad: Introductory Circuit Analysis, 12th edition, Pearson, 2010 ***Further Readings:*** G. Hagmann: Grundlagen der Elektrotechnik (Fundamentals of Electrical Engineering), 15th edition, AULA Verlag, 2011

	G. Hagmann: Aufgabensammlung zu den Grundlagen der Elektrotechnik (Set of exercises regarding Fundamentals of Electrical Engineering), 14th edition, AULA Verlag, 2010 Course materials from the lecturer Laboratory documents and 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. G. Gehnen
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 “Analog Electronic Circuits”

Module name:	Analog Electronic Circuits
Module code:	Electronics: EL_7
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	Prof. Dr.-Ing. G. Gehnen
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:	Course “Direct Current and Net Analysis”
Module objectives:	Students know the fundamental conduction mechanisms in semiconductors and the effects that occur by connecting different types of semiconductors. Based on this, they can describe the functional principle of diodes and transistors. They master the basic circuits of diodes and transistors and are able to calculate the proportions of current and voltage using curves and empirical formulae. They are able to design and to analyse circuits containing operational amplifiers. They know the frequency behaviour of semiconductor components and operational amplifiers and are therefore able to make corresponding assessments for practical application. Based on this knowledge, students are able to estimate the frequency behaviour of circuits as well as to apply the related effects specifically for the operation of oscillating circuits.
Content:	• Semiconductors: Structure and conduction mechanisms • Doping of semiconductors • p-n junction and diodes • Applications of diodes • Special forms of diodes: Z-diodes, Schottky-diodes, LEDs • Bipolar transistors, fundamentals and characteristics

	• Basic transistor circuits • Field effect transistors • Fundamentals of operational amplifiers • Op amp circuits • Frequency-dependent behaviour: Oscillators, timers, and filters • Voltage conversion with linear control systems and clocked circuits
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector, Simulation programmes
Literature:	R. L. Boylestad, L. Nashelsky: Electronic Devices and Circuit Theory, 10th edition, Pearson, 2009 Horowitz, Hill: The Art of Electronics, Cambridge University Press; 1989 ***Further Readings:*** M. Rashid: Microelectronic Circuits, 2nd edition, Cengage Learning, 2011 Tietze, Schenk: Halbleiterschaltungstechnik (Semiconductor circuit Technology), Springer Verlag, 2009 Course materials from the lecturers Laboratory documents and exercises from the lecturers

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 Prof. Dr.-Ing. P. Zhang
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 “Alternating Currents and Mechanics”

Module name:	Alternating Currents and Mechanics
Module code:	Electronics: EL_9
Courses (where applicable):	- Alternating Currents - Elastostatics and Dynamics
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	Prof. Dr.-Ing. G. Gehnen Prof. Dr.-Ing. H. Schütte
Language:	English
Place in curriculum:	Core
Timetabled hours:	Alternating Currents: Lecture: 2 HPW Exercise: 1 HPW Elastostatics and Dynamics: Lecture: 2 HPW Exercise: 1 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Fundamentals of Electrical Engineering and Mechanics”
Module objectives:	Alternating Currents: Students have knowledge of alternating current circuits and can calculate currents, potential differences and impedances with complex numbers. In doing so they are able to calculate the frequency-dependent behaviour of a circuit. Also they are familiar with three-phase circuits and star-delta transformations. Elastostatics and Dynamics: After successfully finishing the module, students are able to analyse simple mechanical machine elements using strength theory as well as to perform fundamental dimensioning of electrotechnical units. They can analyse plane dynamical systems and vibration problems.
Content:	Alternating Currents: • Fundamentals of AC circuit engineering • Calculating with complex numbers in AC circuit

	engineering, pointer indication • Root mean squares and peak values • Calculation of impedance and admittance • Networks in complex notation, phasor • Energy and power in AC networks • Frequency-dependent behaviour • Three phase networks • Triangle and star circuits • Transformation of three phase systems <u>Elastostatics and Dynamics:</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 thrust, oblique bending) • Torsion • Buckling (Euler buckling) • Dynamics of particles • Dynamics of plane rigid bodies • Vibration and time response
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Alternating Currents:</u> R.L. Boylestad: Introductory Circuit Analysis, 12th edition, Pearson, 2010 G. Hagmann: Fundamentals der Elektrotechnik (Fundamentals of Electrical Engineering), 15th edition, AULA Verlag, 2011 <u>Elastostatics and Dynamics:</u> Beer, F.P., Johnston, R.E: Mechanics of Materials, 6th Global Edition, McGraw-Hill, 2011 Meriam,J.L., Kraige, L.G.: Engineering Mechanics: Dynamics SI-Version, 7th ed.

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 “Processor Technology”

Module name:	Processor Technology
Module code:	Electronics: EL_11
Courses (where applicable):	Circuits of Digital Electronic Microcontrollers
Semester:	2nd Semester
Module coordinator:	Prof. Dr. Ing. I. Volosyak
Lecturer:	Prof. Dr. Ing. I. Volosyak
Language:	English
Place in curriculum:	Core
Timetabled hours:	Circuits of Digital Electronic: Lecture: 2 HPW Exercise: 1 HPW Microcontrollers: Lecture: 2 HPW Practicals: 1 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Course “Direct Current and Net Analysis”
Module objectives:	Circuits of Digital Electronic: Students master binary arithmetic. They can create circuits to add and subtract binary numbers using logic gates and the theorems of Boolean algebra. Aided by Karnaugh maps, they can create logic functions according to requirements and assemble them in specific links. They also master typical combinational circuits and storage circuits for technical applications. They know the typical characteristics of digital circuits which use TTL and CMOS circuit techniques. Microcontrollers: Based on data types bit and byte, students master the typical data representation in microcontrollers. They can label the elements of a microcontroller according to Neumann architecture and show the procedural structures for command processing. They are able to write microcontroller instructions using addressing schemes and the set of commands. They can control data input and

	output and they know the essential development tools for creating programs for microcontrollers.
Content:	<u>Circuits of Digital Electronics</u> • The numeric system in binary representation • Digital addition and subtraction • Logic gates and switching algebra • Karnaugh maps • Technical realisation of digital circuits • TTL and CMOS • Combinational circuits • Asynchronous and synchronous circuit engineering • Storage circuits <u>Microcontrollers</u> • Data representation in bits and bytes • Princeton and Harvard architecture • CPU components • Instruction coding and addressing • Data storage • Input and output systems • Development tools
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector, Laboratory experiments
Literature:	T. Floyd: Digital Fundamentals, a systems approach, Pearson, 2012 S. Barret: Embedded Systems Design with the Atmel AVR Microcontroller, Morgan & Claypool Publishers, 2009 ***Further Readings:*** J. Sanchez: Microcontroller Programming [The Microchip PIC], CRC Press, 2007 Klaus Fricke: Digitaltechnik (Digital Technology), Vieweg+ Teubner, 2009 Jan M. Rabaey, Digital Integrated Circuits, Prentice Hall, 2002 Ronald J. Tocci: Digital Systems: Principles and Applications, Prentice Hall, 2010 John F. Wakerly: Digital Design: Principles and Practices, Addison Wesley, 2006 Ioan Susnea, Marian Mitescu: Microcontrollers in Practice, Springer, 2006 N. Senthil Kumar, M. Saravanan, S. Jeevananthan: Microprocessors and Microcontrollers, Oxford University Press, 2011

Module “Materials for Electrical Engineering”

Module name:	Materials for Electrical Engineering
Module code:	Electronics: EL_12
Courses (where applicable):	
Semester:	2nd Semester
Module coordinator:	Prof. Dr. A. Struck
Lecturer:	Prof. Dr. A. Struck
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:	Course “Direct Current and Net Analysis” Module “Fundamentals of Natural Science”
Module objectives:	Students understand the structure of matter and are able to analyze the characteristic properties of materials important for application in Electrical Engineering. This includes a survey of materials and their properties, in particular mechanisms of conduction in metals and semiconductors in terms of band structure and Fermi levels. Students are also familiar with polarisation effects and magnetic characteristics. Moreover, students know features and properties of insulators and construction and contact materials used to build electronic circuits. With the knowledge gained, students are able to select suitable materials or manufactured components for specific applications.
Content:	• Fundamentals of materials • Structure and characteristics of matter • Metallic materials • Semiconductor materials • Dielectric materials • Magnetic materials • Special materials for electrical engineering
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector

Literature:	Rolf E. Hummel: Electronic Properties of Materials, Springer Ellen Ivers-Tiffée, Waldemar von Münch: Werkstoffe der Elektrotechnik (Materials of Electrical Engineering) ***Further Readings:*** N. Basak: Electrical Engineering Materials, New Age Science Ltd, 2009 G. Fasching, Werkstoffe für die Elektrotechnik, Springer, 2005 Course materials from the lecturer Exercises from the lecturer

Module “Manufacture of Electronics”

Module name:	Manufacture of Electronics
Module code:	Electronics: EL_13
Courses (where applicable):	Industrial Manufacture of Electronics Integrated Management Systems
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	External lecturer Prof. Dr.-Ing. A. Klein
Language:	English
Place in curriculum:	Core
Timetabled hours:	<u>Industrial Manufacture of Electronics</u> Lecture: 1 HPW Practicals: 1 HPW <u>Integrated Management Systems</u> Lecture: 2 HPW Exercise: 1 HPW
Workload:	75 h attendance 45 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	Students are able to list the steps of the industrial production process for electronic circuits and master the essential rules of drafting electronic circuits which take production capability into account. They are aware of the problems resulting from different requirements for the finished product and are able to select corresponding manufacturing processes and optimise them. They are familiar with troubleshooting methods and maintenance of circuits in quality control within the framework of industrial manufacturing. Furthermore the course includes the essential fundamentals of integrated management systems. The common focus is 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, environmental and work safety management.

Content:	Industrial Manufacture of Electronics: • Structural engineering of electronic circuits • Soldered connections • Manual soldering • Automatic soldering systems • Inspection systems and quality assurance • Production Management • Maintenance • 3D-MID, Flipchip technologies Integrated Management Systems: • 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:	Industrial Manufacture of Electronics: W. Sauer et al.: Electronics Process Technology: Production Modelling, Simulation and Optimisation, Springer, 2006 Wolf-Dieter Schmidt: Grundlagen der Leiterplatten-Baugruppen-Entwicklung und Fertigung (Fundamentals of PCB devices – Development and Manufacturing), Grin Verlag, 2009 Integrated Management Systems Pardy, Wayne, Andrews, Terri: Integrated Management Systems, Government Institutes, 2010

	Further Readings: Leonhard Stiny: Fertigung und Test elektronischer Baugruppen: Technologie, Fertigungskonzepte, Prüftechnik (Manufacturing and Testing of Electronic Devices: Technology, Production Concepts, Test Engineering), Christiani, 2010 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 “Mathematics of Electronics”

Module name:	Mathematics of Electronics
Module code:	Electronics: EL_14
Courses (where applicable):	- Fields and Waves - Numerics and Statistics
Semester:	3rd Semester
Module coordinator:	Prof. Dr. A. Struck
Lecturer:	Prof. Dr. A. Struck Prof. Dr. A. Kehrein
Language:	English
Place in curriculum:	Core
Timetabled hours:	Fields and Waves: Lecture: 2 HPW Exercise: 1 HPW Numerics and Statistics: Lecture: 2 HPW Exercise: 1 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Mathematics and IT” Module “Applied Mathematics” Module “Fundamentals of Electrical Engineering and Mechanics”” Course “Elastostatics and Electronics”
Module objectives:	<u>Fields and Waves:</u> Students will have a broad theoretical knowledge and understanding of electromagnetic fields and their mathematical description. They apply analytical and numerical methods for calculating electromagnetic fields in various geometries that reflect the needs imposed by practical problems. They identify and analyse field theoretical problems and are able to assess calculation results critically and to present them clearly. Transfer of results determined by theoretical calculation into practical application and recognition of their importance for its purpose is another central objective of the course.

	Numerics and Statistics: Students learn to interpret and summarise data in a meaningful way and to present it graphically in a suitable way. Here the main focus lies on analyses occurring in experiments. Furthermore they should learn how to draw conclusions about a population based on sample data; here especially the application quality assurance should be considered. The fundamentals of probability theory that are necessary for this purpose are developed empirically via experiments by students. Students learn that computer results are not necessarily correct and that their accuracy is often deceptive. Some standard methods are presented, but with the advice that every problem needs its own approach. The importance of drawings for the correct selection and the correct application of numerical methods is emphasised. Students develop a consciousness for the fact that mathematically equivalent formulae can lead to different results in practical calculation.
Content:	Fields and Waves: • Introduction to electric and magnetic fields • Scalar and vector fields • Fundamentals of vector analysis • Differential operators div, rot, grad • Integral operators div-1, rot-1, grad-1 • Potential function, potential equations • Potential and potential function of magnetic fields • Maxwell's equations of electrodynamics • electrostatic and magnetostatic fields via Maxwell's equations with boundaries • Voltage and current equations of long wires • Time-dependent problems, waves • Numerical field calculations • Simulation of typical electromagnetic fields Numerics and Statistics: Statistics: • Introduction: descriptive statistics, probability • Basic concepts: population, sample, qualitative/quantitative data, classification, histograms, scatter plots, stem-leaf-diagrams • Key figures: mean value, median, variance (for population and sample), standard deviation, z-values (standard units) • Regression: correlation and linear regression, non-linear regression • Probability: law of large numbers, probability, conditional probability, probability tree, Bayes' theorem • Random variables: binomial distribution, hypergeometric distribution, normal distribution • Sample theory: sample average, central limit theorem,

	variance of sample average Numerics: • Representation of numbers on a computer, rounding errors, stop errors (such as partial sum of an infinite series), loss of significant digits during subtraction of almost identical items, trade-off: smaller increments reduce stop errors but increase rounding errors • Iterative fixed-points, application of Taylor approximations, stop criteria regarding relative (approximation) error [delivers predetermined number of significant items], discovering a small solution of a squared equation by viewing a linear equation with a squared disorder, Newton method in multiple variables • Numerical integration: centre and trapezoidal rule, Romberg method (includes Simpson rule) • Numeric linear algebra: iterative methods • Numerical solving of initial value problems • Finite differences (numerical differentiation) for boundary value problems
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Fields and Waves:</u> Edward M. Purcell, David J Morin: Electricity and Magnetism, 3rd edition, Cambridge University Press, 2013 Daniel Fleisch: A Student's Guide to Maxwell's Equations, Cambridge University Press, 2008 <u>Numerics and Statistics:</u> DeVeaux, Velleman, Intro Stats. Pearson, 2004 Freedman, Pisani, Purves, Statistics. 4th edition. Norton, 2007 ***Further Readings:*** Schwab. A.J.: Begriffswelt der Feldtheorie (Terminology of Field Theory), Springer Verlag, 2012 Devore, Probability and Statistics for Engineering and the Sciences. 7th int. student edition. Brooks/Cole, 2008 Montgomery, Runger, Applied Statistics and Probability for Engineers. SI Version. 5th edition. Wiley, 2011 Acton, Real Computing made Real. Preventing Errors in Scientific and Engineering Calculations. Dover, 1996 Strang, Wissenschaftliches Rechnen (Scientific Calculation). Springer, 2010. Video lectures Comp. Science and Engineering at http://www.mit.edu -> OpenCourseWare, Burden, Faires, Numerical Analysis. 9th international

	edition. Brooks/Cole, 2011 Press, Teukolsky, Vetterling, Flannery, Numerical Recipes. 3rd edition. Cambridge, 2007

Module “Embedded Systems”

Module name:	Embedded Systems
Module code:	Electronics: EL_15
Courses (where applicable):	
Semester:	3rd Semester
Module coordinator:	Prof. Dr. I. Volosyak
Lecturer:	Prof. Dr. I. Volosyak
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 “Processor Technology” Module “ IT-Programming”
Module objectives:	Students have a broad knowledge of embedded systems for which the boundary conditions of limited resources and hardware dependencies are valid. In particular, they know the processes of modern software development for these systems. Students know how software for embedded systems is structured. They know the drafting process and the tools for creating software for these systems. They understand concepts for testing embedded software. Students are able to select and apply the tools supporting the drafting process for embedded systems. Students are able to specify suitable embedded systems for a given task, to create a suitable software concept for this and to select necessary tools and test environments. They act in a methodical and structured manner in this regard, and use professional tools. Students who have finished this module successfully understand how embedded systems are integrated in an overall system.
Content:	• Architecture of Embedded Systems • Real time behaviour, soft and hard real time • Periphery • Programming with scarce resources • Program implementation: booting, cross-compiling, linking, loading, remote debugging • Hardware abstraction

	• Failure safety • Applications • Petri nets
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector, Laboratory experiments
Literature:	P. Marwedel: Embedded System Design, Springer, 2011 Qing Li, Caroline Yao: Real-Time Concepts for Embedded Systems. CMP Books, 2003. ***Further Readings:*** G. Buttazzo: Hard Real-Time Computing Systems, Springer, 2011 A. Forrai: Embedded Control System Design [A model driven approach], Springer, 2013 Frank Vahid and Tony Givargis: Embedded System Design: A Unified Hardware/Software Introduction. John Wiley & Sons, 2002 Jean J. Labrosse: MicroC/OS-II The Real-Time Kernel 2nd edition. CMP Books, 2002. Arnold S. Berger: Embedded Systems Design. CMP Books, 2001. Jim Cooling: Software Engineering for Real-time Systems. Addison Wesley, 2002.

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 “Signal Transmission”

Module name:	Signal Transmission
Module code:	Electronics: EL_17
Courses (where applicable):	
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	External lecturer
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 “Applied Mathematics” Course “Alternating Currents”
Module objectives:	After finishing this module, students master the differences between continuous and discrete-time signals and their essential applications in communications engineering. They know the characteristics of linear time-invariant systems for continuous and discrete signals. The common transformations needed for calculating communication transmissions are comprehensively mastered by the students.
Content:	• Fundamentals of continuous and discrete systems • Continuous signals and systems • Linear time-invariant systems • Fourier transforms and their applications • Laplace transforms • Applications in communication systems • Time-discrete systems • Z-transformation • Application of time-discrete systems for communications engineering
Test/examination results:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Christoph Arndt: Information Measures: Information and its Description in Science and Engineering, Springer, 2003

	Wolfgang Frohberg, Horst Kolloschie, Helmut Löffler: Taschenbuch der Nachrichtentechnik (Pocket book of Communications Engineering), Carl Hanser Verlag, 2008 ***Further Readings:*** Christoph Arndt: Information Measures: Information and its Description in Science and Engineering, Springer, 2003 Alan Oppenheim, Alan Willsky, with Hamid: Signals and Systems, Pearson International, 1996 Charles Phillips, John Parr, Eve Riskin: Signals, Systems, and Transforms, Pearson International, 2008 Yuriy Shmaliy: Continuous-Time Signals, Springer, 2006 John G. Proakis: Digital Communications, McGraw-Hill, 2000 Martin Werner: Information und Codierung: Fundamentals und Anwendungen (Information and Coding: Fundamentals and Applications), Vieweg und Teubner, 2008

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. G. Gehnen Prof. Dr. Ing. I. Volosyak
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.-Ing. D. Untiedt
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 “Signal Processing”

Module name:	Signal Processing
Module code:	Electronics: EL_20
Courses (where applicable):	Analog Measurement Technology Digital Signal Processing
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	External lecturer
Language:	English
Place in curriculum:	Core
Timetabled hours:	Analog Measurement Technology Lecture: 2 HPW Digital Signal Processing Lecture: 2 HPW Exercise: 1 HPW
Workload:	75 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Analog Electronic Circuits” Module “Alternating Currents and Mechanics”
Module objectives:	Analog Measurement Technology: Students are able to describe the structure of a measuring chain from the physical feature to a sensor up to an abstract electrical representation. They master the methods of error computation necessary for estimating the characteristics of the measuring device. Students are familiar with causes of error and the constructive design of signal processing. They are able to draft a suitable circuit technique based on expected errors, to minimise fault effects. They know a set of typical sensors and are able to deduce fundamental sensor principles even for other applications. Digital Signal Processing: Students master the important methods of signal processing and their theoretical fundamentals. Regarding the objective of an application such as signal improvement or signal compression, they are able to critically assess the

	methods and recognise alternatives. They are able to apply these methods to time-dependent and image signals.
Content:	<u>Analog Measurement Technology:</u> • Basic terminology of Measurement Technology • Parameters of signals, representation of values • Measuring chain and fault effects • Measurement methods • Handling measurement deviations • Typical sensors in practical applications <u>Digital Signal Processing:</u> • Analog and digital signals, digitisation of signals, scan-line theorem • Time-discrete signals, linear time-discrete systems, z-transformation • Stochastic signals • Correlation methods • Discrete Fourier transforms, scanning and windowing • Digital filters, IIR and FIR filter, coefficient determination
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Analog Measurement Technology:</u> Jon Wilson, Sensor Technology Handbook, Newnes, 2004 Toko, Kiyoshi: Biomimetic Sensor Technology, Cambridge University Press, 2000 <u>Digital Signal Processing:</u> D. Ch. von Grünigen: Digitale Signalverarbeitung (Digital Signal Processing), Carl Hanser, 2008 Oppenheim, Schafer, Buck: Discrete-Time Signal Processing, Pearson, 1999 ***Further Readings:*** DIN 1319: Grundlagen der Meßtechnik (Fundamentals of Measurement Technology) Thomas Mühl: Introduction to electrical Measurement Technology; Vieweg und Teubner, 2008 Reinhard Lerch, Elektrische Messtechnik (Electrical Measurement Technology), Springer, 2010 M. Werner: Digital Signal Processing with MATLAB Vieweg+Teubner, 2008 Steven Smith: Digital Signal Processing. A Practical Guide for Engineers and Scientists, Newnes, 2002 John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Pearsons, 2002

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 “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 “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 “Advanced Design Methods”

Module name:	Advanced Design Methods
Module code:	Electronics: EL_25
Courses (where applicable):	- Model Based Hardware Design - Design of Environmentally Friendly Circuits
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	External lecturer
Language:	English
Place in curriculum:	Core
Timetabled hours:	Model Based Hardware Design: Lecture: 1 HPW Practicals: 1 HPW Design of Environmentally Friendly Circuits Lecture: 2 HPW
Workload:	60 h attendance 60 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Embedded Systems”
Module objectives:	Model Based Hardware Design: Students know the different model types for designing electronic circuits. They master the difference between behaviour models and architecture models and are able to partition models in such a way that they are able to transform behaviour models into architecture models step by step. They are able to integrate the models in simulations, thereby verifying them. With concrete examples in VHDL and System-C, they are able to apply the methods and transfer them into practice. Design of Environmentally Friendly Circuits: Students know the life cycle of electronic devices and are able to name the requirements resulting from rules such as IEC 62430. They are able to classify and optimise the design process by means of the energy consumption aspects in the company, the necessary resources for production and disposal.
Content:	Model Based Hardware Design: • Types of models

	• Functional modelling • Behavioural models • Architecture models • Verification and Simulation • VHDL • System C <u>Design of Environmentally Friendly Circuits:</u> • Life cycle of electronic devices • Standards and regulations for the design: IEC 62430 • Operational energy consumption • Production of electronic components • Raw materials and their production • Recycling and environmentally sound waste disposal
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Peter Asherden, The Designer's Guide to VHDL, Morgan Kaufmann, 2006 Thorsten Grötker, Stan Liao: System Design with SystemC, Springer, 2002 ***Further Readings:*** Wolfgang Müller, Wolfgang Rosenstiel, Jürgen Ruf: SystemC: Methodologies and Applications, Springer, 2010 Wolfgang Wimmer et al.: ECODESIGN -- The Competitive Advantage, Springer, 2010

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. G. Gehnen Prof. Dr.-Ing. I. Volosyak
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 “Low Power Design”

Module name:	Low Power Design
Module code:	Electronics: EL_27.1
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	Prof. Dr.-Ing. G. Gehnen
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 2 HPW Exercise: 1 HPW
Workload:	45 h attendance 30 h preparation and review 15 h exam preparation
Credits:	4
Recommended prerequisites:	Module “Analog Electronic Circuits” Course “Alternating Currents” Course “Circuits of Digital Electronic” Module “Embedded Systems”
Module objectives:	Based on the fundamentals of electronic circuit engineering, students are able to name the cause of power consumption and choose measures to minimise power consumption depending on circuit type and area of application. They master design methods to avoid power consumption early on during the design process. They are familiar with the susceptibility to interference of power-optimised circuits. Students are able to select suitable methods from common energy harvesting methods, and apply them, with due consideration of load profiles and production potentials.
Content:	• Causes of power consumption of electronic circuits • Performance optimisation of Analogue circuits • Reduction of power consumption of digital circuits • Processor based systems and their software • Sensitivity towards disturbances • Energy Harvesting
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	John Rabaey, Low Power Design Essentials, Springer,

	2009 Nihal Kularatna: Power Electronics Design Handbook: Low-Power Components and Applications: Low-power Components and Applications, Newnes, 1998 ***Further Readings:*** Nianxiong Nick Tan, Zhihua Wang, Dongmei Li: Ultra-Low Power Integrated Circuit Design: Circuits, Systems, and Applications, Springer, 2011 Laurie Kelly, Piguet Piguet, Christian Piguet: Low-Power Electronics Design, Crc Pr. 2005

Module “Mobile Information Devices”

Module name:	Mobile Information Devices
Module code:	Electronics: EL_27.2
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	External lecturer
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Exercise: 1 HPW
Workload:	30 h attendance 45 h preparation and review 45 h exam preparation
Credits:	2
Recommended prerequisites:	Module “Embedded Systems” Module “IT-Programming”
Module objectives:	Students are able to name the special aspects in the design of mobile devices for information transmission. They master the characteristics of the most important battery technologies and the necessary watchdog and charging circuits. They know modern communication interfaces and systems for determining the position of a device. Students are able to evaluate different technologies for interacting with the user and select and combine them for specific tasks. Students know important operating systems and their characteristics for creating application software running on mobile devices and which are integrated in a network.
Content:	• Features of mobile devices • Battery technology, charging technology • Communication interfaces • Location awareness • User interface • Operating systems and application software • Cloud
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector

Literature:	Axel Küpper: Location-Based Services, Wiley, 2005 B.J. Fogg, Persuasive Technology, Morgan Kaufmann, 2003 ***Further Readings:*** Athanasios Vasilakos , Witold Pedrycz: Ambient Intelligence, Wireless Networking, and Ubiquitous Computing, Artech House Inc., 2006

Module “Audio and Speech Processing”

Module name:	Audio and Speech Processing
Module code:	Electronics: EL_27.3
Courses (where applicable):	
Semester:	4th or 5th Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	Prof. Dr. M. Krauledat
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Practicals: 2 HPW
Workload:	45 h attendance 45 h preparation and review 30h exam preparation
Credits:	4
Recommended prerequisites:	Course “Digital Signal Processing”
Module objectives:	Students master the characteristics of audio signals and their representation in digital systems. They are able to design suitable methods for input, processing and output of audio signals with available resources, within given quality parameters. Students are familiar with the acoustic characteristics of human language. Using these characteristics, they are able to design and apply compression systems as well as synthesised speech.
Content:	• Basic characteristics of audio signals • Representation of audio signals in digital systems • Recording and playback • Characteristics of speech signals • The human ear and its characteristics • Audio analysis • Audio synthesis • Speech processing • Compression of speech and audio
Assessment:	Written or oral examination, laboratory reports
Forms of media:	Whiteboard, PowerPoint, Projector, Practical experiments
Literature:	Ian McLoughlin, Applied Speech And Audio Processing: With Matlab Examples, Cambridge University Press, 2009 Proakis, Digital Signal Processing, Prentice Hall, 2008

	U. Zölzer, Digital Audio Signal Processing, John Wiley & Sons, 2008 ***Further Readings:*** Peter Vary, Rainer Martin, Digital Speech Transmission, John Wiley & Sons, 2006 Course materials from the lecturer

Module “Biomedical Electronics”

Module name:	Biomedical Electronics
Module code:	Electronics: EL_27.4
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. I. Volosyak
Lecturer:	Prof. Dr.-Ing. I. Volosyak
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 “Analog Electronic Circuits” Course “Analog Measurement Technology”
Module objectives:	Students know the fundamentals of electric potential within the human body that can be measured by ECG or EEG for example. They know a selection of sensors supporting different diagnostic processes, by which they are able to select and specify sensor systems for these areas of application. They master basic methods of image processing as used in tomography, for example. The students understand the fundamentals of electrical potentials in the human brain which can be detected with non-invasive and invasive methods. They can derive, from first principles, real architectures for modern Brain-Computer Interfaces. They are aware of the legal and other requirements for medical products and based on this, they are able to estimate which constructive measures are necessary. A brief introduction to implantology allows students to recognise the limits and possibilities of implanting electronic components for supporting sensory and actuatory functions.
Content:	• The body as an electric system • EKG, EEG • Brain-Computer Interfaces • Sensor systems for medical applications • Introduction to image-processing systems • Requirements for medical products

	• Implantable electronics
Assessment:	written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	L. Street: Introduction to Biomedical Engineering Technology, 2nd edition, CRC Press, 2011 W. Saltzmann: Biomedical Engineering, Cambridge University Press, 2009 ***Further Readings:*** J. Enderle: Introduction to Biomedical Engineering, Academic Press, 2011 R. Northrop: Analysis and Application of analog electronic circuits to biomedical instrumentation, CRC Press, 2012 Bronzino, Joseph D.: The Biomedical Engineering Handbook, CRC Press, 2006 G. Schalk, A practical Guide to Brain-Computer Interfacing with BCI2000, Springer, 2010 B. Allison, Towards Practical Brain-Computer Interfaces, Springer, 2012 J. Wolpaw, E. Wolpaw, Brain-Computer Interfaces: Principles and Practice, Oxford Univ Pr, 2012

Module “Recycling of Electronics”

Module name:	Recycling of Electronics
Module code:	Electronics: EL_27.5
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. I. Volosyak
Lecturer:	Prof. Dr.-Ing. I. Volosyak
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:	Module “Materials for Electrical Engineering” Course “Industrial Manufacturing of Electronics”
Module objectives:	Students are able to name the essential materials of which electronic devices are made. They know the main influences on the energy balance in the production of a device. They are able to name recycling processes and to select suitable methods for the individual processing steps. Based on fundamental construction principles, they are able to select suitable constructive measures for facilitating dismantling. They are able to decide on recycling of components. They know basic methods to optimise the lifespan of a device thereby reducing the accumulation of waste. Aside from that, students know the relevant legal regulations for handling electrical waste and related aspects of data protection law.
Content:	• Material composition of electronic devices • Energy balance of production • Recycling processes • Design for efficient dismantling • Reutilisation • Lifespan optimisation • Data protection for recycling of electronic devices and information carriers • Legislation (ROHS, WEEE)
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector

Literature:	Sammy G. Shina: Green Electronics Design and Manufacturing: Implementing Lead-Free and RoHS-Compliant Global Products, McGraw-Hill, 2008 Yun Xing: Shredding Simulation of End of Life Consumer Electronic Products: Computer Modelling Methodology, Vdm Verlag, 2008 ***Further Readings:*** V. Goodship, A. Stevels : Waste Electrical and Electronic Equipment (WEEE) Handbook, Woodhead Publishing Ltd, 2011 R. Kuehr, Eric Williams: Computers and the Environment: Understanding and Managing their Impacts, Springer Netherlands, 2007

Module “Optoelectronics”

Module name:	Optoelectronics
Module code:	Electronics: EL_27.6
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: 2 HPW
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	Course “Fundamentals of Physics”
Module objectives:	Students have a general view of the conversion of light into electronic signals and vice versa. They are able to classify and evaluate optoelectronic components with regard to occurring effects, functions, specifications and areas of application. Students therefore have the skill to dimension and use optoelectronic components in complete systems.
Content:	The lecture starts with the fundamentals of optics and semiconductor physics. The application-related main part is structured in optical signal generation (LED, laser, displays) on the one hand and optical receivers (photodiodes, detector types, solar cells) on the other hand.
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Course materials from the lecturer Physics of photonic devices, S. L. Chuang, Wiley (2009)

Module “Networks in Industrial Automation”

Module name:	Networks in Industrial Automation
Module code:	Electronics: EL_27.7
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. G. Gehnen
Lecturer:	External Lecturer
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:	4
Recommended prerequisites:	
Module objectives:	Students master the basic concepts of bus systems. They are able to distinguish different methods of bit transmission via physical layer and different medium access control mechanisms. Students have knowledge of typical bus systems in industrial automation. They are able to classify the advantages and disadvantages of different bus systems and select suitable bus systems for different cases of application. They are aware of the influence of the Quality of Service of bus systems on the performance of the closed-loop control and take this into account in real applications.
Content:	Basic structure of bus systems/communication interfaces • Terminology of information theory: entropy, redundancy, decision content • Ordinary channel models, channel capacity (Shannon and Nyquist model), influence of disturbances/noise • The ISO/OSI reference model • Physical bit transmission (NRZ/RZ signals, elementary bit coding) • Topologies (ring, star, bus...) • Medium access control protocols (CSMA/CD, CSMA/CA, TDMA, token passing, polling) • Methods for securing and checking data integrity • Quality of Service (QoS) of bus systems (delay,

	jitter, packet loss, bit error rate, …) • Basic principles of analog and digital modulation processes Networked automation systems • Requirement on bus systems • Master/slave operation • Multi-master operation • Influence of QoS of bus systems on the performance of closed-loop control Typical bus systems in industrial automation • ASI • Interbus • Profibus • Foundation Fieldbus • CAN • Flexray • WLAN • Ethernet and TCP/IP/UDP, in particular industrial Ethernet • Placement of interfaces in the ISO/OSI reference model • Advantages and disadvantages of different bus systems • Standardised SW interfaces towards hardware
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	B. Wilamowski and J. D. Irwin, Industrial Communication Systems (The Industrial Electronics Handbook), CRC Press, 2011. R. Zurawski, The Industrial Communication Technology Handbook (The Industrial Information Technology Series), CRC Press, 2005. ***Further Readings:*** B. Reißenweber, Feldbussysteme zur industriellen Kommunikation, Deutscher Industrieverlag, 2009.

Module “Nanoelectronics”

Module name:	Nanoelectronics
Module code:	Electronics: EL_27.8
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr. G. Bastian
Lecturer:	Prof. Dr. G. Bastian Prof. Dr. A. Struck
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:	Module “Analog Electronic Circuits” Module “Mathematics of Electronics” “Module “Signal Transmission”
Module objectives:	Students know the effects of quantum mechanics, which matter at advanced miniaturisation. They master the basic mathematical relationships. They are able to describe the impacts of effects on circuit techniques and to select sensor systems based on these effects. They know single electron effects and spintronical effects and the related circuit techniques.
Content:	• Transition from micro to nanoelectronics • Quantum mechanical effects • Basic structures of nanoelectronics • Fabrication methods of different structures • Applications of quantum effects in nanoelectronics • Quantum computer
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	R. Waser (ed.), Nanoelectronics and Information Technology, Wiley-VCH, 2003 S. Datta, Electron Transport in Mesoscopic Systems, Cambridge University Press, 1995 ***Further Readings:***

	D.K. Ferry and S.M. Goodnick, Transport in Nanostructures, Cambridge University Press, 1997 C.W.J. Beenakker & H. van Houten, in: Solid State Physics, eds. H. Ehrenreich & D. Turnbull, vol. 44, Academic Press, 1991 Y. Imry, Introduction to Mesoscopic Physics, Oxford University Press, 1997 T. Dittrich et al., Quantum Transport and Dissipation, Wiley-VCH, Weinheim, 1998 Course materials from the lecturer

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. G. Gehnen Prof. Dr.-Ing. I. Volosyak
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. G. Gehnen Prof. Dr.-Ing. I. Volosyak
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. G. Gehnen Prof. Dr.-Ing. I. Volosyak
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. G. Gehnen Prof. Dr.-Ing. I. Volosyak
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. G. Gehnen Prof. Dr.-Ing. I. Volosyak
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