Faculty of Technology and Bionics

Module Description

of the study course

„Industrial Engineering B.Sc.“

Rev. 3. Stand: 28.05.2015

Contents

Module "Fundamentals of Natural Science"

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

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

Module “Mathematics and IT”

Module name:	Mathematics and IT
Module code:	Mechanical Engineering: ME_2 Mechatronic Systems Engineering: SE_2 Electronics: EL_2 Industrial Engineering: IE_2
Courses (where applicable):	- Introductory Mathematics - Computer-based Engineering Tools
Semester:	1st Semester
Module coordinator:	Prof. Dr. A. Kehrein
Lecturer:	Prof. Dr. A. Kehrein, Prof. Dr. M. Krauledat Prof. Dr.-Ing. D. Nissing
Language:	English
Place in curriculum:	Core
Timetabled hours:	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. Computer based Engineering Tools: Students are familiar with the software tool MATLAB and the basics of programming. They are able to perform larger calculations during the course of study and they can implement simple mathematical algorithms and analyse them by using helpful tools such as graphical plots or similar.
Content:	Introductory Mathematics: • Numbers: irrational numbers and the difficulties associated with their representation on a pocket calculator or computer, complex numbers and the Fundamental Theorem of Algebra • Systems of linear equations: Gaussian elimination • Vector algebra and analytic geometry: linear combinations, scalar and vector products, straight lines and planes • Limits: concept and computation, continuity, bisection method • Differential calculus: definition of derivative, rules of derivation, tangent, Newton's method, monotonicity and concavity • Integral calculus: inversion of differentiation – indefinite integral, area calculation – definite integral, Fundamental Theorem of calculus Computer based Engineering Tools: • Use MATLAB commands • Plotting in MATLAB • MATLAB program structures (m-files): scripts and functions • Basic programming structures: conditional statements, loops • Symbolic determination of derivatives and integrals • Numerical integration
Assessment:	Introductory Mathematics: written examination Computer based Engineering Tools: attestation
Forms of media:	Whiteboard, PowerPoint, Projector, PC-Pool
Literature:	James Stewart (2011). *Calculus*. Metric International Version. 7th edition. Brooks/Cole ***Further Readings:*** James Stewart, Lothar Redlin, Saleem Watson (2012). *Algebra and Trigonometry.* 3rd international edition. Brooks/Cole [to catch up on basic mathematics] Stormy Attaway (2012). *MATLAB – A Practical Introduction to Programming and Problem Solving*. 2nd edition. Butterworth-Heinemann.

Module “Statics and Electrical Engineering”

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

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

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

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

Module “Creativity and Conflict Management”

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

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

	• Lateral thinking • Innovation types – Brainwriting • Habits of creative people • Product innovations – Checklist methods • Morphological box – Diffusion of innovations • Innovation Management – Fundamentals • Characterisation of creativity methods • Field trip to a place of inspiration…
Assessment:	Conflict Management: Attestation Creativity: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector, Flip-Chart, Moderation kit
Literature:	<u>Creativity:</u> Michael Michalko: Thinkertoys: A Handbook of Creative -Thinking Techniques, ISBN 978-1-58008-773-5, Ten Speed Press, 2006 David Silverstein, Philip Samuel und Neil DeCarlo: The Innovator's Toolkit, 1st edition, ISBN: 978-0-470-34535-1, John Wiley & Sons, 2008 <u>Conflict Management:</u> Joseph P. Folger, Marshall Scott Poole, Rendall K. Stutman: Working through conflict; Strategies for relationships, groups and organizations, 6th edition, Pearson Education, 2009 Roy M. Berko, Andrew D. Wolvin, Darlyn R. Wolvin: Communicating; A social, career and cultural focus, Pearson Education, 2010 ***Further Readings:*** Jurgen Wolff: Creativity, 1st edition, ISBN: 978-0-273-72467-4, Financial Times Prentice Hall, 2009 Edward De Bono: Serious Creativity, ISBN: 978-0-00-637958-4, Harper Collins Publ., 1995 Paul Trott: Innovation Management and New Product Development, 5th revised edition, ISBN: 978-0-273-73656-1, Financial Times Prent. Int, 2011 Friedmann Schulz von Thun: Miteinander reden 1; Störungen und Klärungen; (Communicate 1; Troubles and Clarifications) ISBN: 3 499 17489 8, Rowohlt Verlag, 1998

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

Module “Technical Drawing”

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

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

Module “Cross-Cultural Project Management”

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

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

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

Module “Materials and Testing”

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

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

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

Module “Applied Mathematics”

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

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

Module “Elastostatics, Dynamics, and IT-Programming”

Module name:	Elastostatics, Dynamics, and IT-Programming
Module code:	Industrial Engineering IE_9
Courses (where applicable):	- Elastostatics and Dynamics - IT-Programming
Semester:	2nd Semester
Module coordinator:	Prof. Dr.-Ing. H. Schütte
Lecturer:	Prof. Dr.-Ing. H. Schütte Prof. Dr. M. Krauledat
Language:	English
Place in curriculum:	Core
Timetabled hours:	Elastostatics and Dynamics: Lecture: 2 HPW Exercise: 1 HPW IT-Programming: Lecture: 2 HPW Practicals: 2 HPW
Workload:	105 h attendance 15 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	Module “Statics and Electrical Engineering” Module “Mathematics and IT” Course “Computer-based Engineering Tools”
Module objectives:	Elastostatics and Dynamics: After successfully finishing the module, students are able to conduct design calculations of simple mechanical machine elements based on strength theory. They are able to formulate, analyse and numerically solve problems of engineering dynamics (creating equations of motion). IT-Programming 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:	<u>Elastostatics and Dynamics:</u> • Traction and pressure in bars (stress, strain, material law) • State of stress (stress tensor, plane state of stress, equilibrium conditions) • State of distortion and elasticity law • State of distortion, 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) • Movement of ground point (kinematics, kinetics) • Kinetics of a ground point system • Movement of a rigid body • Principles of mechanics • Oscillations • Relative movement <u>IT-Programming:</u> 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 Object-oriented programming • Brief introduction to the concept of object-oriented programming • Examples by means of a concrete object-oriented programming language (such as: C++, JAVA)
Assessment:	Elastostatics and Dynamics: Written examination IT-Programming: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Elastostatics and Dynamics</u> Beer &Johnston: Mechanics of Materials, 6th ed., Global edition,,McGraw-Hill (2012)

	Craig: Mechanics of Materials, 3rd ed., Wiley (2011) IT-Programming: Kernighan, Brian W. und Ritchie, Dennis M.: The C Programming Language, 2nd edition, Prentice Hall International, ISBN 978-0131103627, 1988 ***Further Readings:*** Meriam & Kraige: Engineering Mechanics: Dynamics, 7th ed., SI Version, Wiley (2012) 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 “Purchasing, Sales and Business Law”

Module name:	Purchasing, Sales and Business Law
Module code:	Industrial Engineering IE_10
Courses (where applicable):	- Purchasing and Sales of Technical Products - Fundamentals of Business Law
Semester:	3rd Semester
Module coordinator:	Prof. Dr. D. Berndsen
Lecturer:	Prof. Dr. D. Berndsen External lecturer
Language:	English
Place in curriculum:	Core
Timetabled hours:	Purchasing and Sales of Technical Products: Lecture: 2 HPW Fundamentals of Business Law: Lecture: 2 HPW
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	An economy based on the division of labour requires the exchange of goods and services among businesses. This module enables students to understand, apply and analyse the processes and structures necessary for this exchange from different angles. Students know the methodical fundamentals of organising purchases, types of goods and acquisition strategies. They are especially able to select and apply suitable context-specific methods and tools of technical purchasing. The students know the difference between strategic and operational purchasing. Students are familiar with the most important basic terms of technological distribution. They understand the interplay of technological products, markets and market segments, customer preferences and pricing. They are able to critically deliberate and evaluate distribution structures and processes. After completing the module, students should be able to understand, recognise and apply the fundamental principles of business law. Here, the focus lies on the legal treatment of economic activities of natural persons. They are able to judge legal developments and to evaluate their meaning for business life. Students know the

	requirements for conclusion of a contract as well as the general framework of performance of a contract. They are able to hold a nuanced view of the legal treatment of private individuals and companies and to analyse them. In particular • they understand economic and legal backgrounds of contract design, • they are able to handle the most important contractual instruments of acquisition and distribution, • they understand legal thinking and action as well as legal requirements of the business • they are skilled in working at the interface to legal knowledge carriers in commercial enterprises.
Content:	<u>Purchase and Distribution of Technical Products</u> • Order processing • Market cultivation • Distribution strategy • Product planning and marketing • Distribution of products and services • Terms and objectives of acquisition • Financial importance of acquisition • Single, modular, system and global sourcing • Material groups and supplier strategy • Supplier management • Organisation of acquisition • Analysis of purchasing programme (ABC, XYZ analysis) • Purchase pricing and negotiations • Statistical methods of demand forecasts and disposition methods, and optimal order volume <u>Fundamentals of Business Law</u> • Legal system and legal procedure • Contractual particularities among merchants, merchant perception • Function of trade register • Corporate forms • Conclusion of contract • Content and performance of a contract • Law of general terms and conditions • Compliance, particularly conveyance • Product liability
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Lysons, K.; Farrington, B.: Purchasing and Supply Chain Management. 7th edition, Prentice Hall, 2006

	Tanner, J. F.; Honeycutt, E. D.; Erffmeyer, R. C.: Sales Management – Shaping the future. Prentice Hall, 2009 Marson, J.: Business Law. Oxford, 2009 ***Further Readings:*** Van Weele, A. J.: Purchasing and Supply Chain Management – Analysis, Strategy, Planning & Practice, 5th edition, Hampshire: South-Western Cengage Learning, 2010 Cousins et al.: Strategic Supply Management: Principles, Theories and Practice, Harlow: FT Prentice Hall, 2008 MacIntyre, E.: Business Law 4th ed., Pearson & Longman, 2008 Further material and scripts from the lecturers

Module “Technical Design”

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

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

Module “Thermodynamics”

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

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

Module “Manufacturing and Quality”

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

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

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

Module "Accounting"

Module name:	Accounting
Module code:	Industrial Engineering IE_14
Courses (where applicable):	- Internal Accounting - External Accounting
Semester:	3rd Semester
Module coordinator:	Prof. Dr. D. Berndsen
Lecturer:	Prof. Dr. D. Berndsen Prof. Dr. D. Berndsen
Language:	English
Place in curriculum	Core
Timetabled hours:	Internal Accounting: Lecture: 2 HPW External Accounting: Lecture: 2 HPW
Workload:	60 h attendance 45 h preparation and review 45 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	Students will gain the ability to solve problems independently with application-related, fundamental knowledge of accounting. After finishing the module, students have profound knowledge about structure and processes of bookkeeping and balancing. They become acquainted with accounting as the core administrative system for documentation and analysis of overall business relationships. Students recognise the informational function of accounting, specifically for interested parties outside the company.
Content:	First the course introduces the fundamentals of financial accounting. It concerns the segments bookkeeping and annual financial statements especially. The second part of the module deals with cost accounting. Internal Accounting • Cost behaviour • Ratio analysis and financial management • Working Capital Management • Variable costing

	• Absorption costing • Activity based costing • Pricing • Transfer pricing • Budgeting <u>External Accounting</u> • Recording Process • Adjusting the Accounts • Accounting Cycle • Inventories • Accounting for Receivable • Plant Assets, Natural Resources, and Intangible Assets • Liabilities • Corporations: Organisations, Share Transactions, Dividends, and Retained Earnings • Investments • Statement of Cash Flows • Financial Statement Analysis
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Weygandt, K.J.; Kimmel, P.D.; Kieso, D.E.: Financial Accounting: IFRS Edition. 1st Edition, John Wiley & Sons, 2010 Proctor, R.: Managerial Accounting for Business Decisions. 3rd edition, Prentice Hall, 2009 ***Further Readings:*** Weygandt, J. J.; Kimmel, P. D.; Kieso, D. E.: Managerial Accounting. 4th edition, Wiley, 2008 Materials and scripts from lecturers

Module “Statistics and Logistics”

Module name:	Statistics and Logistics
Module code:	Industrial Engineering IE_15
Courses (where applicable):	- Numerics and Statistics - Logistics
Semester:	3rd Semester
Module coordinator:	Prof. Dr.-Ing. A. Klein
Lecturer:	Prof. Dr. A. Kehrein Prof. Dr.-Ing. A. Klein
Language:	English
Place in curriculum:	Core
Timetabled hours:	Numerics und Statistics Lecture: 2 HPW Exercise: 1 HPW Logistics Lecture: 2 HPW Practicals: 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 objectives:	Analysis of material flows, optimisation of stock, material flow routes and ordering cycles, modelling and planning of logistic systems. Among other things, all those tasks named above require profound application knowledge of statistics and numerics. Against this background, students should learn how to interpret data, compile it in a meaningful way and display it in a suitable graphical manner. Special emphasis is put on interpretations that occur with respect to logistical problems. Furthermore, students will be acquainted with the basic logistical concepts of different areas of function in a commercial enterprise. They master the different methods of analysis for determining logistical key figures. Based on this, students will be able to analyse practical problems of logistics as well as classify and solve them.
Content:	Numeric and Statistics: • Introduction: descriptive and closing statistics, role of probability calculus;

	• Basic concepts: entirety, sample, qualitative/quantitative data, classification, histograms, scatter charts, stem-leaf-diagrams • Key figures: mean value, median, variance (for entirety and sample), standard deviation, z-values (standard units) • Regression: correlation and linear regression, non-linear regression • Probability calculus: 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 • Number representation on the computer, rounding errors, stop errors (such as partial sum of an infinite series), loss of significant digits at subtraction of almost identical items, smaller increments reduce stop errors, however they 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 (among other things numerical differentiation) for marginal problem <u>Logistics:</u> • Conceptual fundamentals • Acquisition logistics • Production logistics, factory logistics • Transport logistics, rolling stock • Supply chain management • Cost management and logistics • Distribution networks • Warehousing, picking and shipment • Scheduling problems • Typical optimisation problems in logistics • Modelling and planning of logistical systems
Assessment:	Numerics and Statistics: Written examination Logistics: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Numeric and Statistics:</u> DeVeaux, Velleman (2004). Intro Stats. Pearson.

	Freedman, Pisani, Purves (2007). Statistics. 4th edition. Norton. <u>Logistics:</u> Chopra, S.; Meindl, P.: Supply Chain Management. 4th edition, Prentice Hall, 2010 ***Further Readings:*** Christopher, M.: Logistics and Supply Chain Management. Financial Times Series; 4th Revised edition, 2010 Devore (2008). Probability and Statistics for Engineering and the Sciences. 7th international student edition. Brooks/Cole M**o**ntgomery, Runger (2011). Applied Statistics and Probability for Engineers. SI Version. 5th edition. Wiley Video lectures Computational Science and Engineering at http://www.mit.edu -> OpenCourseWare Burden, Faires (2011). Numerical Analysis. 9th international edition. Brooks/Cole Murphy, P. R.; Wood, D.: Contemporary Logistics. 9th edition, Prentice Hall, 2008

Module “Fundamentals of Process Engineering”

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

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

Module “Fundamentals of Economics”

Module name:	Fundamentals of Economics
Module code:	Industrial Engineering IE_17
Courses (where applicable):	- Business Economics - Economics
Semester:	2nd Semester
Module coordinator:	Prof. Dr. D. Berndsen
Lecturer:	Prof. Dr. D. Berndsen Prof. Dr. D. Berndsen
Language:	English
Place in curriculum:	Core
Timetabled hours:	Business Economics Lecture: 2 HPW Economics Lecture: 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 know the main issues of general business economics and know how to handle them. In particular, they are able to analyse and evaluate the core areas of activity, functions, core processes and decisions within a market-based enterprise and to apply this knowledge in the practice. They show an understanding of different legal forms of companies and know how to evaluate them with regard to business resources and objectives. They gain an understanding of different business functions and practices and their effects on the successful operation of a business. Students know and understand the fundamental economic relationships of a labour-based, globalised business world and are able to develop elementary solution approaches for economic issues. They know basic micro-economic methods and contexts and are able to analyse consumer and producer behaviour of goods and factor markets. Furthermore they are informed about macro-economic contexts and are able to understand and analyse these.
Content:	Business economic Fundamentals • General business economics

	• Foundation of a company • Legal structure • Marketing and distribution • Fundamentals of production • Business management and organisation • Investment and financing • Controlling <u>Economics</u> • Fundamentals of micro-economics • Basic terms and relationships of macro-economics
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Mankiw, N. G.; Taylor, M. P.: Economics. Cengage Learning EMEA, UK, 2010 O´Sullivan; Sheffrin; Perez: Microenonomics – Principles, Applications, and Tools. 6th edition, Pearson Education, Inc. Publishing as Prentice Hall, 2010 ***Further Readings:*** Wöhe, G.: Einführung in die Allgemeine Betriebswirtschaftslehre (Introduction to Business), 24th ed., Munich, 2010 Dias, L.P./Shah, A. J.: Introduction to Business, Boston et al. 2009 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 Pride, W.M.; Hughes, R.J.; Kapoor, J.R.: Introduction to Business, 11th ed., Australia et al., 2010

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. D. Untiedt
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 “Production Management”

Module name:	Production Management
Module code:	Industrial Engineering IE_19
Courses (where applicable):	- Fundamentals of Production - Management of Production Systems
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. A. Klein
Lecturer:	Prof. Dr.-Ing. A. Klein
Language:	English
Place in curriculum:	Core
Timetabled hours:	<u>Fundamentals of Production:</u> Lecture: 2 HPW <u>Management of Production Systems:</u> Lecture: 2 HPW Practicals: 2 HPW
Workload:	90 h attendance 30 h preparation and review 30 h exam preparation
Credits:	5
Recommended prerequisites:	
Module objectives:	Students know the various problems of production management and are able to arrange them in an overall frame. From an economic view of production, students have profound knowledge of production and cost theory and in particular of production functions. Based on the theoretical fundamentals of production, they know different types of organisation of production and their planning tasks as well as the relevant planning, controlling and monitoring systems. They know the interdependencies on the bordering areas of function such as acquisition, sales, R&D and costing. Students are acquainted with the main principles of production management. They are able to recognise optimising problems in industrial production and develop suitable solution approaches. They are able to derive a production concept from the general strategy of an enterprise.
Content:	• Subject and terms of production • Production and cost theory • Production factors

	• Production functions • Production • Manufacturing depth • Factory layout • Global footprint design • Production programme planning, aggregate planning • Economies of scale and economies of scope • Organisational structures in production • Production optimisation • Lean Production, Kanban etc. • Production controlling
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Heizer, J.; Render, B.: Principles of Operations Management. 8th edition, Prentice Hall, 2011 Stevenson, W. J.: Operations Management. 10th revised edition. McGraw-Hill, 2008 ***Further readings:*** Bloech, J.; Bogaschewsky, R.; Buscher, U.; Daub, A.; Götze, U.; Roland, F.: Einführung in die Produktion (Introduction to Production). 6th edition, Springer, 2008 Fandel, G. Fistek, A., Stütz, S.: Produktionsmanagement (Production Management). 2nd edition, Springer, 2010 Stevenson, W. J.: Operations Management. 11th revised edition. McGraw-Hill, 2011 Hopp, Wallace J.; Spearman, Mark L.: Factory Physics. 3rd edition, McGraw-Hill, 2011 Nyhuis, Peter; Wiendahl, Hans-Peter: Fundamentals of Production Logistics. Springer, 2008 Lödding, Hermann: Handbook of Manufacturing Control, Springer, 2013 Further materials from lecturer

Module “Technology and Innovation Management”

Module name:	Technology and Innovation Management
Module code:	Industrial Engineering IE_20
Courses (where applicable):	- Technology and Life Cycle Management - Innovation Management
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	Prof. Dr.-Ing. D. Untiedt
Language:	English
Place in curriculum:	Core
Timetabled hours:	Technology and Life Cycle Management: Lecture: 2 HPW Innovation Management: 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 know the essential terms, methods and tools of technology and innovation management. They are able to arrange technologies and to evaluate these using suitable methods. They are aware of the importance of technologies for businesses and society. They know the methods and tools of technology for early detection, planning and evaluation and are able to apply these to practical problem cases. Students know the importance of innovations for businesses. They are acquainted with the relationships between innovation process, stakeholders and the internal and external business environments. They are able to apply suitable methods and instruments of innovation management in an objective-oriented manner in everyday operation. For this, a clear understanding is gained of the innovation process, its success factors and its management and controlling instruments. After completing the module, students should be able to create technology portfolios and to apply roadmaps. Furthermore they should have basic knowledge in the areas of projections and scenarios. In particular they are able to

	evaluate technological innovations with regard to chances and risks, but also with regard to their dangers.
Content:	<u>Technology and Life cycle management</u> • Fundamentals of Technology management • Scope of duties of Technology management • Technology foresight • Technology planning • Protection of intellectual property • Technology evaluation • Formulation of Technology strategies <u>Innovation management</u> • Basics concepts of Innovation management • Innovation processes and structures • Innovation strategies • Methods of Innovation management • Generating ideas and creativity • Open Innovation
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	<u>Technology and Life cycle management</u> Schuh, G.; Klappert, S.: Technologiemanagement (Technology Management). Springer, 2010 Betz, F.: Managing Technological Innovation – Competitive Advantage from Change. 3rd edition, John Wiley & Sons, 2011 <u>Innovation management</u> Trott, P.: Innovation Management and new product development. 4th edition. Pearson Education Ltd., 2008 Schuh, G. (Hrsg.): Innovationsmanagement. Handbuch Produktion und Management 3. Zweite, vollständig neu bearbeitete und erweiterte Auflage, Springer, 2012 ***Further Readings:*** Burgelmann, R.: Strategic Management of Technology and Innovation. 5th revised edition, McGraw-Hill Higher Education, 2008 Arnold, H.; Erner, M.; Möckel, P.; Schläffer, Chr. (Eds.): Applied Technology and Innovation Management. Springer, 2010 Narayanan, V. K.; Colarelli O'Connor, G. (Eds.): Encyclopedia of Technology and Innovation Management. 1st edition, John Wiley & Sons, 2010

Module “Modelling and Simulation”

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

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

Module “Measurement Engineering and Controls”

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

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

Module “Product and Service Engineering”

Module name:	Product and Service Engineering
Module code:	Industrial Engineering IE_23
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. P. Kisters
Lecturer:	Prof. Dr.-Ing. P. Kisters Prof. Dr.-Ing. D. Untiedt
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:	Module “Technical Drawing”
Module objectives:	Students analyse the full life cycle of a product from conception to recycling. They define requirements for product development and utilisation of the product. They recognise that aside from production costs, operational costs are also of fundamental importance for the acceptance of a product. Students apply their knowledge early on in the product development phase. They deduce strategies with which the usage phase of the product can be prolonged, and develop services for this with the target of minimising “Total Cost of Ownership”. Improvement of reliability and availability of products and plants are important objectives for the students. With this course, students are able to combine product with service development. They realise the resulting potentials and are anxious to form close customer relationships.
Content:	• Definition of the life cycle of a product • Introduction to “Total-Cost of Ownership” • Splitting costs between brainstorming, development, manufacturing and usage phase • Development strategies (design to market, design to cost etc.) • Introducing the concepts of reliability and availability

	• Calculation of availabilities for products and plants • FMEA as development tool • Holistic development process under consideration of usage phase • Expanding the product range by product related services • Condition-Monitoring as an instrument of availability increase • Effects of Condition-Monitoring for the manufacturer and the customer • Turn-Key-Projects • Effects of Condition-Monitoring on After-Sales
Assessment:	Attestation
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Gerhard Pahl, W. Beitz, Hans-Joachim Schulz, U. Jarecki: Engineering Design: A Systematic Approach, 3rd edition, ISBN 978-1846283185, Springer London, 2006 Karkowski, Salvendy: Introduction to Service Engineering, 1st edition, ISBN 978-0470382417, John Wiley & Sons, 2010 ***Further Readings:*** K. Schneider, H.-J. Bullinger, A.-W. Scheer: Service Engineering: Entwicklung und Gestaltung innovativer Dienstleistungen (Developing and Designing innovative Services), 2nd, completely rev. and expanded ed., ISBN 978-3540253242, Springer-Verlag, Berlin, 2005 Script from lecturer Exercise material from lecturer

Module “Financing and Entrepreneurship”

Module name:	Financing and Entrepreneurship
Module code:	Industrial Engineering IE_24
Courses (where applicable):	- Investment and Financing - Entrepreneurship
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	Prof. Dr. D. Berndsen Prof. Dr.-Ing. D. Untiedt
Language:	English
Place in curriculum:	Core
Timetabled hours:	Investment and Financing: 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 “Fundamentals of Economics” Course “Fundamentals of Business Law”, Module “Accounting”
Module objectives:	Entrepreneurial thinking and acting of the students will be trained specifically with regard to the main responsibilities of business establishment. After finishing the module, they are able to analyse and evaluate markets, market developments, customer values and competitive advantages. They show fundamental knowledge of generating business plans in which the business concept always remains the focal point. They learn how to apply individual management methods and instruments of decision-making. Furthermore, students are familiar with the basics of business financing. They know financing types and rules. They are acquainted with alternative forms of financing and they are able to evaluate these in a context-specific way.
Content:	Investment and Financing • Financing types and financing rules • Liquidity

	• Internal and external financing • Alternative forms of financing <u>Entrepreneurship</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:	Investment and Financing: Written examination Entrepreneurship: Attestation
Forms of media:	Whiteboard, PowerPoint, Projector, Business game
Literature:	Barringer, B. R.; Ireland, D.: Entrepreneurship – Successfully Launching New Ventures, 4th edition, Prentice Hall, 2012. Guerard, J. B.; Schwartz, E.: Quantitative Corporate Finance. Springer, 2007. ***Further Readings:*** Wöhe, G.; Bilstein, J.; Ernst, D.; Häcker, J.: Grundzüge der Unternehmensfinanzierung (Basics of Business Financing). 10th edition, Vahlen, 2009 Lambing, P. A.; Kuehl, Ch. R.: Entrepreneurship. 4th edition, Prentice Hall, 2007 Bygrave, W. D.; Zacharakis, A.: Entrepreneurship. Wiley, 2008

Module “Strategic Management”

Module name:	Strategic Management
Module code:	Industrial Engineering IE_25
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	Prof. Dr.-Ing. D. Untiedt
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:	Module “Fundamentals of Economics” Module “Purchasing, Sales and Business Law” Module “Accounting” Module “Production Management” Module “Technology and Innovation Management”
Module objectives:	Students know the main methods and instruments of strategic management. They have the ability to use them effectively. They are able to formulate strategies and implementation plans on all strategy levels and in specific contexts.
Content:	• Fundamentals of strategic Management • Positioning • Environment analysis • Strategic objectives • Culture, guiding principles and vision • Levels of strategic planning • Methods of strategy development • Change Management The theoretical knowledge gained in the sector of STRATEGIC MANAGEMENT will be simulated and deepened by an IT based business game.
Assessment:	Written examination
Forms of media:	Whiteboard, PowerPoint, Projector, Business game

Literature:	Grant, R. M.: Contemporary strategy analysis. 7th edition, Wiley, 2010 Malik, F.: Managing, Performing, Living – Effective Management for a New Era. Campus Verlag, 2006 ***Further Readings:*** Johnson, G.; Whittington, A.; Scholes, K.: Exploring Strategy – Text and Cases. 9th edition, Prentice Hall, 2011 David, F. R.: Strategic Management – Concepts and Cases. 12th edition, Prentice Hall, 2009 Müller-Stewens, G.; Lechner, Chr.: Strategisches Management: Wie strategische Initiativen zum Wandel führen (Strategic Management: How Strategic Initiatives lead to Change). 4th edition, Schäffer Poeschel, 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. D. Untiedt
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 “Technical and Economical Cost Management”

Module name:	Technical and Economical Cost Management
Module code:	Industrial Engineering IE_27.1
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	External Lecturer
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Exercise: 1 HPW
Workload:	30 h attendance 30 h preparation and review 30 h exam preparation
Credits:	3
Recommended prerequisites:	Module “Accounting” Module “Fundamentals of Economics”
Module objectives:	The question of how costs within a business are analysed and influenced in a positive way corresponding to the objectives of the business is the focal point of this module. Students have deep knowledge of cost management in businesses. They are acquainted with suitable methods and instruments and can apply them in a context-specific way. Furthermore, students have special knowledge of the cost management in projects. They are able to transfer the learnt knowledge to practical issues.
Content:	• Functions of cost management • Instruments of cost management (Target Costing, activity accounting, Product Life Cycle Costing, direct costing, overhead expense value analysis, design accompanying calculation, value analysis, Balanced Scorecard) • Cost management in projects
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Eldenburg, L. G.; Wolcott, S.: Cost management - Measuring, Monitoring, and Motivating Performance. Wiley, 2005 Ostwald, Ph. F.; McLaren, T. S.: Cost Analysis and

	Estimating for Engineering and Management. Prentice Hall, 2004

Module “Computer Integrated Manufacturing (CIM)”

Module name:	Computer Integrated Manufacturing (CIM)
Module code:	Industrial Engineering IE_27.2
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. A. Klein
Lecturer:	External Lecturer
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Exercise: 1 HPW
Workload:	30 h attendance 15 h preparation and review 15 h exam preparation
Credits:	2
Recommended prerequisites:	Course “IT-Programming” Module ”Manufacturing and Quality” Module “Production Management” Module “Modelling and Simulation” Module “Measurement Engineering and Controls”
Module objectives:	Students gain deeper knowledge of computer-based production. They understand the workflow and processing steps from the design of a machine or components to their manufacturing.
Content:	Main components of computer based production: • CAM, CAD-CAM chain • Workflow from early design stage to finished part • CAx technologies, such as • Computer Aided Quality (management) CAQ • Computer Aided Engineering CAE Furthermore basics about: • Product data management PDM • Computerized numerical control CNC • Enterprise resource planning ERP • Manufacturing execution systems MES
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector

Literature:	Rehg, J. A.; Kraebber, H. W.: Computer Integrated Manufacturing. 3rd edition, Prentice Hall, 2005 ***Further Readings:*** Scheer A.-W.: CIM Computer Integrated Manufacturing: Der computergesteuerte Industriebetrieb (The computer-controlled Industrial Enterprise). Springer, 4th edition, 2007 Materials of lecturer.

Module “Management Information Systems (MIS)”

Module name:	Management Information Systems (MIS)
Module code:	Industrial Engineering IE_27.3
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	External Lecturer
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Exercise: 1 HPW
Workload:	30 h attendance 30 h preparation and review 30 h exam preparation
Credits:	3
Recommended prerequisites:	Course “IT-Programming” Module “Purchasing, Sales and Business Law” Module “Accounting” Module “Fundamentals of Economics”
Module objectives:	Management information systems originated from reporting. In these, all essential information and data necessary for business management is made available in compiled and edited form. It does not concern hardware or software, but rather the infrastructure that makes essential data from distribution, production, marketing and purchase available for management. Students are introduced to main contents and typical structure of MIS. They are familiar with essential functions of MIS. They are able to interpret provided information such as variance analyses and are able to apply MIS for explorations of trends.
Content:	• Contents and functions of MIS • Performance Measurement Systems • Socio-technical design of MIS • Implementing of MIS • Examples of common MIS
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	O'Brien, James: Management Information Systems. 10th

	global ed., McGraw-Hill Higher Education, 2011 Laudon , K.C.; Laudon J.P.: Management Information Systems. 13th global ed. Pearson Education Limited, 2013 **Further Readings:** Schermann, M.: Managementinformationssysteme – Praxisgerechte Steuerungstools auf Basis der Balanced Scorecard (Management Information Systems – Practical Control Tools based on the Balanced Scorecard). Linde, 2007

Module “Technical Investment Planning”

Module name:	Technical Investment Planning
Module code:	Industrial Engineering IE_27.4
Courses (where applicable):	
Semester:	4th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	Prof. Dr.-Ing. D. Untiedt
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Project 3 HPW
Workload:	45 h attendance 65 h preparation and review 10 h exam preparation
Credits:	4
Recommended prerequisites:	Module “Cross-Cultural Project Management” Module “Accounting” Module “Fundamentals of Economics”
Module objectives:	Students are able to evaluate planned technological investments. They are able to systematize issues, to formulate investment-planning tasks, to compile requirement and functional specifications if applicable and to select suitable methods and instruments of evaluation. They are able to evaluate results, assess them critically and to present them to a well-informed audience.
Content:	Within the framework of a project, a limited (industrial) investment project is made available to students. Students work in teams. They analyse the task, create requirement and functionality specifications when applicable, invite offers and evaluate investment alternatives according to technical and especially economical points of view. There will be a presentation of the overall results of the investment project.
Assessment:	Oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Literature and material from lecturer

Module “Technology Assessment”

Module name:	Technology Assessment
Module code:	Industrial Engineering IE_27.5
Courses (where applicable):	
Semester:	4th or 5th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	External Lecturer
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 “Fundamentals of Economics” Module “Technology and Innovation Management”
Module objectives:	Students are aware of the importance of the application of technologies. They know the essential technology evaluation methods and are able to distinguish between qualitative and quantitative methods in particular. They are able to judge and determine evaluation standards regarding different objectives and independent variables. They are able to apply the learned knowledge to real problems in practice. They are able to differentiate between business objectives and society objectives for the application of technologies and to evaluate them critically.
Content:	• Analyses of strengths and weaknesses • Analyses of opportunities and risks • Portfolio analyses • Technology life cycle models • S-bend concepts • Roadmaps • Technology impact assessment • Scenario Management • Net Present Value Methods • Real option approaches
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector

Literature:	Bidgoli, Hossein: The Handbook of Technology Management. Volume 1-3. John Wiley & Sons, Inc., 2010

Module “Strategic Business Development”

Module name:	Strategic Business Development
Module code:	Industrial Engineering IE_27.6
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	External Lecturer
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Exercise: 1 HPW
Workload:	30 h attendance 20 h preparation and review 10 h exam preparation
Credits:	2
Recommended prerequisites:	Module “Strategic Management”
Module objectives:	For companies, it is increasingly difficult to differentiate themselves from competitors through product, service and process innovation, since these are quick and easy imitable. For this reason, business models are the focus of current discussions because they are harder to imitate, are based on customer needs, combining together different elements of a company and thus instigate a customer benefit. Students learn to apply methods that make it possible to develop customized, future-oriented and technology-oriented business models. The focus is on the business-to-business markets.
Content:	• Basic theoretical principles • Approaches to Business Development • Method of Business Model Innovation • Business models in business-to-business markets
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Copper, Ian: Financial Times Guide to Business Development: How to Win Profitable Customers and Clients. Financial Times Prent.Int, 2012

	Further Readings: Schallmo, D.: Geschäftsmodell-Innovation: Grundlagen, bestehende Ansätze, methodisches Vorgehen und B2B-Geschäftsmodelle. Springer Gabler, 2013

Module “Product Lifecycle Management”

Module name:	Product Lifecycle Management
Module code:	Industrial Engineering IE_27.7
Courses (where applicable):	
Semester:	5th Semester
Module coordinator:	Prof. Dr.-Ing. D. Untiedt
Lecturer:	External Lecturer
Language:	English
Place in curriculum:	Elective
Timetabled hours:	Lecture: 1 HPW Exercise: 1 HPW
Workload:	30 h attendance 15 h preparation and review 15 h exam preparation
Credits:	2
Recommended prerequisites:	Module “Technical Design” Module “Manufacturing and Quality” Module “Accounting” Module “Statistics and Logistics” Module “Production Management” Module “Technology and Innovation Management”
Module objectives:	Students are familiar with management of the product life cycle (PLM) as a holistic management approach. They know its objectives and are able to evaluate the management of the product life cycle in socio-economical and ecological context. They know typical procedural and structural characteristics of PLM approaches and are able to apply essential methods and tools of PLM in different process phases.
Content:	• Processes and structures of PLM • Methods and Instruments of PLM • Operational information systems supporting the PLM (PDM, ERP, SCM, CRM systems)
Assessment:	Written or oral examination
Forms of media:	Whiteboard, PowerPoint, Projector
Literature:	Sendler, U.: Das PLM Kompendium – Referenzbuch des Produkt-Lebenszyklus-Managements (The PLM-Compendium – Reference Book of Product – Lifecycle-

	Management). Springer, Berlin/Heidelberg/New York, 2009 Saaksvuori, Antti; Immonen, Anselmi: Product Lifecycle Management. 3rd ed., Springer, 2008 **Further Readings:** Sendler, U.; Wawer, V.: Von PDM zu PLM. Prozessoptimierung durch Integration (From PDM to PLM – Process Optimisation by Integration). 3rd, revised and expanded edition. Hanser Verlag, Munich/Vienna, 2011

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. D. Untiedt
Lecturer:	Supervisor of the internship
Language:	English
Place in curriculum	Core
Timetabled hours:	none
Workload:	900 h
Credits:	30
Recommended prerequisites:	Min. 90 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. D. Untiedt
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. D. Untiedt
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. D. Untiedt
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. D. Untiedt
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