



Module Manual

Master of Science (M.Sc.)

Product Development, Materials and Production

Cohort: Winter Term 2020

Updated: 20th April 2023

Table of Contents

Table of Contents	2
Program description	4
Core Qualification	5
Module M0523: Business & Management	5
Module M0524: Non-technical Courses for Master	6
Module M0603: Nonlinear Structural Analysis	8
Module M0742: Thermal Energy Systems	10
Module M0751: Vibration Theory	12
Module M0808: Finite Elements Methods	13
Module M0846: Control Systems Theory and Design	15
Module M1150: Continuum Mechanics	17
Module M1151: Material Modeling	19
Module M1173: Applied Statistics	21
Module M1204: Modelling and Optimization in Dynamics	23
Module M0604: High-Order FEM	25
Module M0805: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)	27
Module M0807: Boundary Element Methods	29
Module M1164: Practical Course Product Development, Materials and Production	31
Module M0752: Nonlinear Dynamics	33
Module M1339: Design optimization and probabilistic approaches in structural analysis	34
Module M0806: Technical Acoustics II (Room Acoustics, Computational Methods)	36
Module M1140: Technical Complementary Course Core Studies for PEPMS (according to Subject Specific Regulations)	
Module M1184: Research Project Product Development, Materials and Production	3938
Specialization Product Development	40
Module M0763: Aircraft Energy Systems (FS1)	40
Module M1024: Methods of Integrated Product Development	42
Module M1025: Fluidics	44
Module M1193: Cabin Systems Engineering	47
Module M0511: Electricity Generation from Wind and Hydro Power	50
Module M0630: Robotics and Navigation in Medicine	53
Module M0764: Flight Control Systems (FS2)	55
Module M0811: Medical Imaging Systems	57
Module M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)	58
Module M1156: Systems Engineering	71
Module M1161: Turbomachinery	73
Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)	75
Module M1226: Mechanical Properties	88
Module M0840: Optimal and Robust Control	90
Module M1344: Processing of fibre-polymer-composites	92
Module M1343: Fibre-polymer-composites	94
Module M1174: Automation Technology and Systems	96
Module M0563: Robotics	98
Module M0771: Flight Physics	100
Module M0815: Product Planning	102
Module M0830: Environmental Protection and Management	104
Module M0867: Production Planning & Control and Digital Enterprise	106
Module M0962: Sustainability and Risk Management	108
Module M1155: Aircraft Cabin Systems	110
Module M1183: Laser Systems and Methods of Manufacturing Design and Analysis	112
Module M1342: Polymers	114
Module M1170: Phenomena and Methods in Materials Science	116
Module M0812: Aircraft Design I (Civil Aircraft Design)	118
Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)	120
Specialization Production	121
Module M0763: Aircraft Energy Systems (FS1)	121
Module M0867: Production Planning & Control and Digital Enterprise	123
Module M1183: Laser systems and methods of manufacturing design and analysis	125
Module M1193: Cabin Systems Engineering	127
Module M0511: Electricity Generation from Wind and Hydro Power	130
Module M0630: Robotics and Navigation in Medicine	133
Module M0764: Flight Control Systems (FS2)	135
Module M0811: Medical Imaging Systems	137
Module M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)	138
Module M1156: Systems Engineering	151
Module M1161: Turbomachinery	153
Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)	155
Module M1226: Mechanical Properties	168
Module M0840: Optimal and Robust Control	170
Module M1343: Fibre-polymer-composites	172
Module M1344: Processing of fibre-polymer-composites	174
Module M1174: Automation Technology and Systems	176

Module M0563: Robotics	178
Module M0771: Flight Physics	180
Module M0815: Product Planning	182
Module M0830: Environmental Protection and Management	184
Module M0962: Sustainability and Risk Management	186
Module M1024: Methods of Integrated Product Development	188
Module M1155: Aircraft Cabin Systems	190
Module M1025: Fluidics	192
Module M1342: Polymers	195
Module M1170: Phenomena and Methods in Materials Science	197
Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)	199
Specialization Materials	200
Module M0763: Aircraft Energy Systems (FS1)	200
Module M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)	202
Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)	215
Module M1193: Cabin Systems Engineering	228
Module M0511: Electricity Generation from Wind and Hydro Power	231
Module M0630: Robotics and Navigation in Medicine	234
Module M0764: Flight Control Systems (FS2)	236
Module M0811: Medical Imaging Systems	238
Module M1156: Systems Engineering	239
Module M1161: Turbomachinery	241
Module M1226: Mechanical Properties	243
Module M0840: Optimal and Robust Control	245
Module M1343: Fibre-polymer-composites	247
Module M1344: Processing of fibre-polymer-composites	249
Module M1174: Automation Technology and Systems	251
Module M0563: Robotics	253
Module M0771: Flight Physics	255
Module M0815: Product Planning	257
Module M0830: Environmental Protection and Management	259
Module M0867: Production Planning & Control and Digital Enterprise	261
Module M0962: Sustainability and Risk Management	263
Module M1024: Methods of Integrated Product Development	265
Module M1155: Aircraft Cabin Systems	267
Module M1025: Fluidics	269
Module M1183: Laser Systems and Methods of Manufacturing Design and Analysis	272
Module M1342: Polymers	274
Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)	276
Module M1170: Phenomena and Methods in Materials Science	277
Thesis	279
Module M-002: Master Thesis	279

Program description

Content

The consecutive master program "product development, materials and production" extends the education in engineering, mathematics and natural science of the bachelor studies. It provides systematic, scientific and autonomous problem solving capabilities needed in industry and research. The following phases of the product creation process are covered: strategic product planning; systematic and methodical development of products including concept development, design, material selection, simulation and testing; production including its planning and control, the use of modern production methods and high-performance materials. Students specialize in one of the three disciplines and acquire the ability to work at the interfaces of the disciplines. Students can choose from a wide range of electives and customize their studies very flexibly according to their individual needs and interests.

Career prospects

The consecutive Master course "product development, materials and production" prepares graduates for a wide range of job profiles in mechanical engineering. Graduates can work directly in their specialization area: product development, materials or production. They gain knowledge about numerous methods and about the work at interfaces between different disciplines that enables them to interdisciplinary work. Graduates may decide for direct entry into companies or to take up academic careers, e.g. Ph.D. studies, in universities or other research institutions. In companies they can take up jobs as specialists (e.g. designer, simulation engineer, production planner) or subsequently qualify for demanding management tasks in the technical area (e.g. project, group, or team leader; R&D or production manager or technical director). The program is designed to be universal and allows graduates to work in a variety of different industrial sectors (especially in mechanical engineering) and with different products.

Learning target

Graduates of the program are able to transfer the individually acquired specialized knowledge to new unknown topics, to grasp, to analyze and to scientifically solve complex problems of their discipline. They can find missing information and plan as well as execute theoretical and experimental studies. They are able to judge, evaluate and question scientific engineering results critically as well as making decisions based on this foundation and draw further conclusions. They are able to act methodically, to organize smaller projects, to select new technologies and scientific methods and to advance these further, if necessary.

Graduates can develop and document new ideas and solutions, independently or in team work. They are capable of presenting and arguing the results to professionals. They can estimate their own strengths and weaknesses as well as possible consequences of their actions. They are capable to familiarize themselves with complex tasks, define new tasks, develop the necessary knowledge for solving it and to systematically apply appropriate means.

Product Development

In the product development specialization, graduates learn to work systematically and methodically on challenging design tasks. They have a wide knowledge of new development methods, are able to select appropriate solution strategies and use these autonomously to develop new products. They are qualified to use the approaches of integrated product development, such as simulation or modern testing procedures, for example for the development of lightweight products. With their additional knowledge about modern high-performance materials and production processes graduates can design products on the cutting edge of technology, calculate and actively promote the development of products using modern methods.

Materials

Graduates of the discipline materials are able to work in the development, production and application of materials based on a natural scientific education. The material-oriented graduates can identify new fields of application and make the application-specific selection of the material under consideration of function, costs and quality.

Production

Graduates of the discipline production have in-depth knowledge of various production and manufacturing processes. They are qualified to evaluate those in the context of geometry creation, error control, cost effectiveness and humanization of work and are able to consider the interfaces of technology, organization and human, holistically.

Program structure

The course is designed modular and is based on the university-wide standardized course structure with uniform module sizes (multiples of six credit points (CP)). The mechanical engineering course combines the disciplines product development, materials and production and allows the deepening in one of these specializations. The students can broadly personalize their studies due to high number and variety of elective courses.

In the common core skills, students take the following modules:

- Finite element analysis and vibration theory (12 CP)
- Fundamental elective courses (catalog) (12 CP)
- Practical Course (6 CP)
- Complementary courses business and management (catalog) (6 CP)
- Nontechnical elective complementary courses (catalog) (6 CP).

Students specialize by selecting one of the following areas, each covering 36 credit points:

- Product development (product development methods, lightweight design)
- Production (production management, production technology)
- Materials (engineering materials).

Within each area of specialization three modules with six credit points are mandatory. An additional 18 credits can be chosen from a module catalog containing modules with a size of six credits. Instead, open modules can be attend to the maximum extent of twelve credit points, in which smaller specialized courses can be combined, individually.

Students write a master thesis and one additional scientific project work.

- Project work (12 CP)
- Master thesis (30 CP)

Core Qualification

The students extend their knowledge and skills in advanced engineering subjects (e.g. vibration theory), in business and management as well as other non-technical topics. Students deepen their autonomous methodological and scientific problem solving skills in the field of product development, materials and production by attending a practical course and by writing a scientific project work.

Module M0523: Business & Management

Module Responsible	Prof. Matthias Meyer
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to find their way around selected special areas of management within the scope of business management. Students are able to explain basic theories, categories, and models in selected special areas of business management. Students are able to interrelate technical and management knowledge. <i>Skills</i> <ul style="list-style-type: none"> Students are able to apply basic methods in selected areas of business management. Students are able to explain and give reasons for decision proposals on practical issues in areas of business management. Personal Competence <i>Social Competence</i> <ul style="list-style-type: none"> Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems <i>Autonomy</i> <ul style="list-style-type: none"> Students are capable of acquiring necessary knowledge independently by means of research and preparation of material. 	
Workload in Hours	Depends on choice of courses
Credit points	6

Courses

Information regarding lectures and courses can be found in the corresponding module handbook published separately.

Module M0524: Non-technical Courses for Master	
Module Responsible	Dagmar Richter
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence <i>Knowledge</i>	<p>The Nontechnical Academic Programms (NTA)</p> <p>imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its teaching architecture, in its teaching and learning arrangements, in teaching areas and by means of teaching offerings in which students can qualify by opting for specific competences and a competence level at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.</p> <p>The Learning Architecture</p> <p>consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses.</p> <p>The learning architecture demands and trains independent educational planning as regards the individual development of competences. It also provides orientation knowledge in the form of "profiles".</p> <p>The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to study these subjects in one or two specific semesters during the course of studies.</p> <p>Teaching and Learning Arrangements</p> <p>provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately encouraged in specific courses.</p> <p>Fields of Teaching</p> <p>are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, communication studies, migration studies and sustainability research, and from engineering didactics. In addition, from the winter semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups in a goal-oriented way.</p> <p>The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goal-oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.</p> <p>The Competence Level</p> <p>of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. These differences are reflected in the practical examples used, in content topics that refer to different professional application contexts, and in the higher scientific and theoretical level of abstraction in the B.Sc.</p> <p>This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leadership functions of Bachelor's and Master's graduates in their future working life.</p> <p>Specialized Competence (Knowledge)</p> <p>Students can</p> <ul style="list-style-type: none"> • explain specialized areas in context of the relevant non-technical disciplines, • outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area, • different specialist disciplines relate to their own discipline and differentiate it as well as make connections, • sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, • Can communicate in a foreign language in a manner appropriate to the subject.
<i>Skills</i>	<p>Professional Competence (Skills)</p> <p>In selected sub-areas students can</p> <ul style="list-style-type: none"> • apply basic and specific methods of the said scientific disciplines, • question a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline, • to handle simple and advanced questions in aforementioned scientific disciplines in a successful manner, • justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.
Personal Competence <i>Social Competence</i>	<p>Personal Competences (Social Skills)</p>

Module Manual M.Sc. "Product Development, Materials and Production"

<p><i>Autonomy</i></p>	<p>Students will be able</p> <ul style="list-style-type: none"> • to learn to collaborate in different manner, • to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees, • to express themselves competently, in a culturally appropriate and gender-sensitive manner in the language of the country (as far as this study-focus would be chosen), • to explain nontechnical items to auditorium with technical background knowledge. <p>Personal Competences (Self-reliance)</p> <p>Students are able in selected areas</p> <ul style="list-style-type: none"> • to reflect on their own profession and professionalism in the context of real-life fields of application • to organize themselves and their own learning processes • to reflect and decide questions in front of a broad education background • to communicate a nontechnical item in a competent way in written form or verbally • to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
<p>Workload in Hours</p>	<p>Depends on choice of courses</p>
<p>Credit points</p>	<p>6</p>

<p>Courses</p>
<p>Information regarding lectures and courses can be found in the corresponding module handbook published separately.</p>

Module M0603: Nonlinear Structural Analysis			
Courses			
Title	Typ	Hrs/wk	CP
Nonlinear Structural Analysis (L0277)	Lecture	3	4
Nonlinear Structural Analysis (L0279)	Recitation Section (small)	1	2
Module Responsible	Prof. Alexander Düster		
Admission Requirements	None		
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	<p>Students are able to</p> <ul style="list-style-type: none"> + give an overview of the different nonlinear phenomena in structural mechanics. + explain the mechanical background of nonlinear phenomena in structural mechanics. + to specify problems of nonlinear structural analysis, to identify them in a given situation and to explain their mathematical and mechanical background. 		
<i>Skills</i>	<p>Students are able to</p> <ul style="list-style-type: none"> + model nonlinear structural problems. + select for a given nonlinear structural problem a suitable computational procedure. + apply finite element procedures for nonlinear structural analysis. + critically verify and judge results of nonlinear finite elements. + to transfer their knowledge of nonlinear solution procedures to new problems. 		
Personal Competence			
<i>Social Competence</i>	<p>Students are able to</p> <ul style="list-style-type: none"> + solve problems in heterogeneous groups and to document the corresponding results. + share new knowledge with group members. 		
<i>Autonomy</i>	<p>Students are able to</p> <ul style="list-style-type: none"> + acquire independently knowledge to solve complex problems. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	<p>Civil Engineering: Specialisation Structural Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Materials Science: Specialisation Modeling: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory Ship and Offshore Technology: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory</p>		

Course L0277: Nonlinear Structural Analysis	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	1. Introduction 2. Nonlinear phenomena 3. Mathematical preliminaries 4. Basic equations of continuum mechanics 5. Spatial discretization with finite elements 6. Solution of nonlinear systems of equations 7. Solution of elastoplastic problems 8. Stability problems 9. Contact problems
Literature	[1] Alexander Düster, Nonlinear Structural Analysis, Lecture Notes, Technische Universität Hamburg-Harburg, 2014. [2] Peter Wriggers, Nonlinear Finite Element Methods, Springer 2008. [3] Peter Wriggers, Nichtlineare Finite-Elemente-Methoden, Springer 2001. [4] Javier Bonet and Richard D. Wood, Nonlinear Continuum Mechanics for Finite Element Analysis, Cambridge University Press, 2008.

Course L0279: Nonlinear Structural Analysis	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0742: Thermal Energy Systems			
Courses			
Title	Typ	Hrs/wk	CP
Thermal Energy Systems (L0023)	Lecture	3	5
Thermal Energy Systems (L0024)	Recitation Section (large)	1	1
Module Responsible	Prof. Gerhard Schmitz		
Admission Requirements	None		
Recommended Previous Knowledge	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	Students know the different energy conversion stages and the difference between efficiency and annual efficiency. They have increased knowledge in heat and mass transfer, especially in regard to buildings and mobile applications. They are familiar with German energy saving code and other technical relevant rules. They know to differ different heating systems in the domestic and industrial area and how to control such heating systems. They are able to model a furnace and to calculate the transient temperatures in a furnace. They have the basic knowledge of emission formations in the flames of small burners and how to conduct the flue gases into the atmosphere. They are able to model thermodynamic systems with object oriented languages.		
<i>Skills</i>	Students are able to calculate the heating demand for different heating systems and to choose the suitable components. They are able to calculate a pipeline network and have the ability to perform simple planning tasks, regarding solar energy. They can write Modelica programs and can transfer research knowledge into practice. They are able to perform scientific work in the field of thermal engineering.		
Personal Competence			
<i>Social Competence</i>	The students are able to discuss in small groups and develop an approach.		
<i>Autonomy</i>	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	60 min		
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0023: Thermal Energy Systems	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	<p>1. Introduction</p> <p>2. Fundamentals of Thermal Engineering 2.1 Heat Conduction 2.2 Convection 2.3 Radiation 2.4 Heat transition 2.5 Combustion parameters 2.6 Electrical heating 2.7 Water vapor transport</p> <p>3. Heating Systems 3.1 Warm water heating systems 3.2 Warm water supply 3.3 piping calculation 3.4 boilers, heat pumps, solar collectors 3.5 Air heating systems 3.6 radiative heating systems</p> <p>4. Thermal treatment systems 4.1 Industrial furnaces 4.2 Melting furnaces 4.3 Drying plants 4.4 Emission control 4.5 Chimney calculation 4.6 Energy measuring</p> <p>5. Laws and standards 5.1 Buildings 5.2 Industrial plants</p>
Literature	<ul style="list-style-type: none"> • Schmitz, G.: Klimaanlagen, Skript zur Vorlesung • VDI Wärmeatlas, 11. Auflage, Springer Verlag, Düsseldorf 2013 • Herwig, H.; Moschallski, A.: Wärmeübertragung, Vieweg+Teubner Verlag, Wiesbaden 2009 • Recknagel, H.; Sprenger, E.; Schrammek, E.-R.: Taschenbuch für Heizung- und Klimatechnik 2013/2014, 76. Auflage, Deutscher Industrieverlag, 2013

Course L0024: Thermal Energy Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0751: Vibration Theory			
Courses			
Title	Typ	Hrs/wk	CP
Vibration Theory (L0701)	Integrated Lecture	4	6
Module Responsible	Prof. Norbert Hoffmann		
Admission Requirements	None		
Recommended Previous Knowledge	<ul style="list-style-type: none"> • Calculus • Linear Algebra • Engineering Mechanics 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p><i>Knowledge</i> Students are able to denote terms and concepts of Vibration Theory and develop them further.</p> <p><i>Skills</i> Students are able to denote methods of Vibration Theory and develop them further.</p> <p><i>Personal Competence</i></p> <p><i>Social Competence</i> Students can reach working results also in groups.</p> <p><i>Autonomy</i> Students are able to approach individually research tasks in Vibration Theory.</p>		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	2 Hours		
Assignment for the Following Curricula	<p>Energy Systems: Core Qualification: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory</p> <p>Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory</p> <p>Mechatronics: Core Qualification: Compulsory</p> <p>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory</p> <p>Product Development, Materials and Production: Core Qualification: Compulsory</p> <p>Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory</p>		

Course L0701: Vibration Theory	
Typ	Integrated Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	WiSe
Content	Linear and Nonlinear Single and Multiple Degree of Freedom Oscillations and Waves.
Literature	K. Magnus, K. Popp, W. Sextro: Schwingungen. Physikalische Grundlagen und mathematische Behandlung von Schwingungen. Springer Verlag, 2013.

Module M0808: Finite Elements Methods				
Courses				
Title	Typ		Hrs/wk	CP
Finite Element Methods (L0291)	Lecture		2	3
Finite Element Methods (L0804)	Recitation Section (large)		2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> The students possess an in-depth knowledge regarding the derivation of the finite element method and are able to give an overview of the theoretical and methodical basis of the method.</p> <p><i>Skills</i> The students are capable to handle engineering problems by formulating suitable finite elements, assembling the corresponding system matrices, and solving the resulting system of equations.</p> <p>Personal Competence</p> <p><i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions.</p> <p><i>Autonomy</i> The students are able to independently solve challenging computational problems and develop own finite element routines. Problems can be identified and the results are critically scrutinized.</p>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	No	20 %	Midterm	
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following Curricula	Civil Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Product Development, Materials and Production: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory			

Course L0291: Finite Element Methods	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> - General overview on modern engineering - Displacement method - Hybrid formulation - Isoparametric elements - Numerical integration - Solving systems of equations (statics, dynamics) - Eigenvalue problems - Non-linear systems - Applications - Programming of elements (Matlab, hands-on sessions) - Applications
Literature	Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

Course L0804: Finite Element Methods	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0846: Control Systems Theory and Design			
Courses			
Title	Typ	Hrs/wk	CP
Control Systems Theory and Design (L0656)	Lecture	2	4
Control Systems Theory and Design (L0657)	Recitation Section (small)	2	2
Module Responsible	Prof. Herbert Werner		
Admission Requirements	None		
Recommended Previous Knowledge	Introduction to Control Systems		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students can explain how linear dynamic systems are represented as state space models; they can interpret the system response to initial states or external excitation as trajectories in state space They can explain the system properties controllability and observability, and their relationship to state feedback and state estimation, respectively They can explain the significance of a minimal realisation They can explain observer-based state feedback and how it can be used to achieve tracking and disturbance rejection They can extend all of the above to multi-input multi-output systems They can explain the z-transform and its relationship with the Laplace Transform They can explain state space models and transfer function models of discrete-time systems They can explain the experimental identification of ARX models of dynamic systems, and how the identification problem can be solved by solving a normal equation They can explain how a state space model can be constructed from a discrete-time impulse response <i>Skills</i> <ul style="list-style-type: none"> Students can transform transfer function models into state space models and vice versa They can assess controllability and observability and construct minimal realisations They can design LQG controllers for multivariable plants They can carry out a controller design both in continuous-time and discrete-time domain, and decide which is appropriate for a given sampling rate They can identify transfer function models and state space models of dynamic systems from experimental data They can carry out all these tasks using standard software tools (Matlab Control Toolbox, System Identification Toolbox, Simulink) Personal Competence <i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions. <i>Autonomy</i> Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems. They can assess their knowledge in weekly on-line tests and thereby control their learning progress.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	Electrical Engineering: Core Qualification: Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Compulsory Aircraft Systems Engineering: Specialisation Avionic Systems: Elective Compulsory Computational Science and Engineering: Specialisation II. Engineering Science: Elective Compulsory International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Core Qualification: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Compulsory		

Course L0656: Control Systems Theory and Design	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	<p>State space methods (single-input single-output)</p> <ul style="list-style-type: none"> • State space models and transfer functions, state feedback • Coordinate basis, similarity transformations • Solutions of state equations, matrix exponentials, Caley-Hamilton Theorem • Controllability and pole placement • State estimation, observability, Kalman decomposition • Observer-based state feedback control, reference tracking • Transmission zeros • Optimal pole placement, symmetric root locus <p>Multi-input multi-output systems</p> <ul style="list-style-type: none"> • Transfer function matrices, state space models of multivariable systems, Gilbert realization • Poles and zeros of multivariable systems, minimal realization • Closed-loop stability • Pole placement for multivariable systems, LQR design, Kalman filter <p>Digital Control</p> <ul style="list-style-type: none"> • Discrete-time systems: difference equations and z-transform • Discrete-time state space models, sampled data systems, poles and zeros • Frequency response of sampled data systems, choice of sampling rate <p>System identification and model order reduction</p> <ul style="list-style-type: none"> • Least squares estimation, ARX models, persistent excitation • Identification of state space models, subspace identification • Balanced realization and model order reduction <p>Case study</p> <ul style="list-style-type: none"> • Modelling and multivariable control of a process evaporator using Matlab and Simulink <p>Software tools</p> <ul style="list-style-type: none"> • Matlab/Simulink
Literature	<ul style="list-style-type: none"> • Werner, H., Lecture Notes „Control Systems Theory and Design“ • T. Kailath "Linear Systems", Prentice Hall, 1980 • K.J. Astrom, B. Wittenmark "Computer Controlled Systems" Prentice Hall, 1997 • L. Ljung "System Identification - Theory for the User", Prentice Hall, 1999

Course L0657: Control Systems Theory and Design	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1150: Continuum Mechanics				
Courses				
Title		Type	Hrs/wk	CP
Continuum Mechanics (L1533)		Lecture	2	3
Continuum Mechanics Exercise (L1534)		Recitation Section (small)	2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear continuum mechanics as taught, e.g., in the module Mechanics II (forces and moments, stress, linear strain, free-body principle, linear-elastic constitutive laws, strain energy).			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<div><div>Knowledge</div><div>The students can explain the fundamental concepts to calculate the mechanical behavior of materials.</div></div> <div><div>Skills</div><div>The students can set up balance laws and apply basics of deformation theory to specific aspects, both in applied contexts as in research contexts.</div></div> <div><div>Personal Competence</div><div><div>Social Competence</div><div>The students are able to develop solutions, to present them to specialists in written form and to develop ideas further.</div></div><div><div>Autonomy</div><div>The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and solve problems in the area of continuum mechanics and acquire the knowledge required to this end.</div></div></div>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory			

Course L1533: Continuum Mechanics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> kinematics of undeformed and deformed bodies balance equations (balance of mass, balance of energy, ...) stress states material modelling
Literature	R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker I-S. Liu: Continuum Mechanics, Springer

Course L1534: Continuum Mechanics Exercise	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • kinematics of undeformed and deformed bodies • balance equations (balance of mass, balance of energy, ...) • stress states • material modelling
Literature	<p>R. Greve: Kontinuumsmechanik: Ein Grundkurs für Ingenieure und Physiker</p> <p>I-S. Liu: Continuum Mechanics, Springer</p>

Module M1151: Material Modeling				
Courses				
Title	Typ		Hrs/wk	CP
Material Modeling (L1535)	Lecture		2	3
Material Modeling (L1536)	Recitation Section (small)		2	3
Module Responsible	Prof. Christian Cyron			
Admission Requirements	None			
Recommended Previous Knowledge	Basics of linear and nonlinear continuum mechanics as taught, e.g., in the modules Mechanics II and Continuum Mechanics (forces and moments, stress, linear and nonlinear strain, free-body principle, linear and nonlinear constitutive laws, strain energy)			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> The students can explain the fundamentals of multidimensional constitutive material laws</p> <p><i>Skills</i> The students can implement their own material laws in finite element codes. In particular, the students can apply their knowledge to various problems of material science and evaluate the corresponding material models.</p> <p><i>Personal Competence</i> The students are able to develop solutions, to present them to specialists and to develop ideas further.</p> <p><i>Autonomy</i> The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and solve problems in the area of materials modeling and acquire the knowledge required to this end.</p>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	45 min			
Assignment for the Following Curricula	Materials Science: Specialisation Modeling: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory			

Course L1535: Material Modeling	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	<p>One of the most important questions when modeling mechanical systems in practice is how to model the behavior of the materials of their different components. In addition to simple isotropic elasticity in particular the following phenomena play key roles</p> <ul style="list-style-type: none"> - anisotropy (material behavior depending on direction, e.g., in fiber-reinforced materials) - plasticity (permanent deformation due to one-time overload, e.g., in metal forming) - viscoelasticity (absorption of energy, e.g., in dampers) - creep (slow deformation under permanent load, e.g., in pipes) <p>This lecture briefly introduces the theoretical foundations and mathematical modeling of the above phenomena. It is complemented by exercises where simple examples problems are solved by calculations and where the implementation of the content of the lecture in computer simulations is explained. It will also briefly discussed how important material parameters can be determined from experimental data.</p>
Literature	

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1536: Material Modeling	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1173: Applied Statistics				
Courses				
Title	Typ		Hrs/wk	CP
Applied Statistics (L1584)	Lecture		2	3
Applied Statistics (L1586)	Project-/problem-based Learning		2	2
Applied Statistics (L1585)	Recitation Section (small)		1	1
Module Responsible	Prof. Michael Morlock			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of statistical methods			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Students can explain the statistical methods and the conditions of their use.</p> <p><i>Skills</i> Students are able to use the statistics program to solve statistics problems and to interpret and depict the results</p> <p>Personal Competence</p> <p><i>Social Competence</i> Team Work, joined presentation of results</p> <p><i>Autonomy</i> To understand and interpret the question and solve</p>			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	None	Written elaboration	
Examination	Written exam			
Examination duration and scale	90 minutes, 28 questions			
Assignment for the Following Curricula	<p>Mechanical Engineering and Management: Specialisation Management: Elective Compulsory</p> <p>Mechatronics: Specialisation System Design: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Biomedical Engineering: Core Qualification: Compulsory</p> <p>Product Development, Materials and Production: Core Qualification: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory</p>			

Course L1584: Applied Statistics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	<p>The goal is to introduce students to the basic statistical methods and their application to simple problems. The topics include:</p> <ul style="list-style-type: none"> • Chi square test • Simple regression and correlation • Multiple regression and correlation • One way analysis of variance • Two way analysis of variance • Discriminant analysis • Analysis of categorical data • Choosing the appropriate statistical method • Determining critical sample sizes
Literature	<p>Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University, Lawrence L. Kupper University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University, Published by Duxbury Press, CB © 1998, ISBN/ISSN: 0-534-20910-6</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1586: Applied Statistics	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The students receive a problem task, which they have to solve in small groups (n=5). They do have to collect their own data and work with them. The results have to be presented in an executive summary at the end of the course.
Literature	Selbst zu finden

Course L1585: Applied Statistics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Michael Morlock
Language	DE/EN
Cycle	WiSe
Content	The different statistical tests are applied for the solution of realistic problems using actual data sets and the most common used commercial statistical software package (SPSS).
Literature	Student Solutions Manual for Kleinbaum/Kupper/Muller/Nizam's Applied Regression Analysis and Multivariable Methods, 3rd Edition, David G. Kleinbaum Emory University Lawrence L. Kupper University of North Carolina at Chapel Hill, Keith E. Muller University of North Carolina at Chapel Hill, Azhar Nizam Emory University, Published by Duxbury Press, Paperbound © 1998, ISBN/ISSN: 0-534-20913-0

Module M1204: Modelling and Optimization in Dynamics				
Courses				
Title	Typ		Hrs/wk	CP
Flexible Multibody Systems (L1632)	Lecture		2	3
Optimization of dynamical systems (L1633)	Lecture		2	3
Module Responsible	Prof. Robert Seifried			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> Mathematics I, II, III Mechanics I, II, III, IV Simulation of dynamical Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Students demonstrate basic knowledge and understanding of modeling, simulation and analysis of complex rigid and flexible multibody systems and methods for optimizing dynamic systems after successful completion of the module.</p> <p><i>Skills</i> Students are able</p> <ul style="list-style-type: none"> + to think holistically + to independently, securely and critically analyze and optimize basic problems of the dynamics of rigid and flexible multibody systems + to describe dynamics problems mathematically + to optimize dynamics problems <p>Personal Competence</p> <p><i>Social Competence</i> Students are able to</p> <ul style="list-style-type: none"> + solve problems in heterogeneous groups and to document the corresponding results. <p><i>Autonomy</i> Students are able to</p> <ul style="list-style-type: none"> + assess their knowledge by means of exercises. + acquaint themselves with the necessary knowledge to solve research oriented tasks. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the Following Curricula	<p>Energy Systems: Core Qualification: Elective Compulsory</p> <p>Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory</p> <p>Mechatronics: Specialisation System Design: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Product Development, Materials and Production: Core Qualification: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p>			

Course L1632: Flexible Multibody Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried, Dr. Alexander Held
Language	DE
Cycle	WiSe
Content	<ol style="list-style-type: none"> 1. Basics of Multibody Systems 2. Basics of Continuum Mechanics 3. Linear finite element modelles and modell reduction 4. Nonlinear finite element Modelles: absolute nodal coordinate formulation 5. Kinematics of an elastic body 6. Kinetics of an elastic body 7. System assembly
Literature	<p>Schwertassek, R. und Wallrapp, O.: Dynamik flexibler Mehrkörpersysteme. Braunschweig, Vieweg, 1999.</p> <p>Seifried, R.: Dynamics of Underactuated Multibody Systems, Springer, 2014.</p> <p>Shabana, A.A.: Dynamics of Multibody Systems. Cambridge Univ. Press, Cambridge, 2004, 3. Auflage.</p>

Course L1633: Optimization of dynamical systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Robert Seifried
Language	DE
Cycle	WiSe
Content	<ol style="list-style-type: none"> 1. Formulation and classification of optimization problems 2. Scalar Optimization 3. Sensitivity Analysis 4. Unconstrained Parameter Optimization 5. Constrained Parameter Optimization 6. Stochastic optimization 7. Multicriteria Optimization 8. Topology Optimization
Literature	<p>Bestle, D.: Analyse und Optimierung von Mehrkörpersystemen. Springer, Berlin, 1994.</p> <p>Nocedal, J. , Wright , S.J. : Numerical Optimization. New York: Springer, 2006.</p>

Module M0604: High-Order FEM				
Courses				
Title	Typ		Hrs/wk	CP
High-Order FEM (L0280)	Lecture		3	4
High-Order FEM (L0281)	Recitation Section (large)		1	2
Module Responsible	Prof. Alexander Düster			
Admission Requirements	None			
Recommended Previous Knowledge	Knowledge of partial differential equations is recommended.			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Students are able to</p> <ul style="list-style-type: none"> + give an overview of the different (h, p, hp) finite element procedures. + explain high-order finite element procedures. + specify problems of finite element procedures, to identify them in a given situation and to explain their mathematical and mechanical background. <p><i>Skills</i> Students are able to</p> <ul style="list-style-type: none"> + apply high-order finite elements to problems of structural mechanics. + select for a given problem of structural mechanics a suitable finite element procedure. + critically judge results of high-order finite elements. + transfer their knowledge of high-order finite elements to new problems. <p>Personal Competence</p> <p><i>Social Competence</i> Students are able to</p> <ul style="list-style-type: none"> + solve problems in heterogeneous groups and to document the corresponding results. <p><i>Autonomy</i> Students are able to</p> <ul style="list-style-type: none"> + assess their knowledge by means of exercises and E-Learning. + acquaint themselves with the necessary knowledge to solve research oriented tasks. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	No	10 %	Presentation	Forschendes Lernen
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following Curricula	<p>Energy Systems: Core Qualification: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory</p> <p>Materials Science: Specialisation Modeling: Elective Compulsory</p> <p>Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory</p> <p>Mechatronics: Technical Complementary Course: Elective Compulsory</p> <p>Product Development, Materials and Production: Core Qualification: Elective Compulsory</p> <p>Naval Architecture and Ocean Engineering: Core Qualification: Elective Compulsory</p> <p>Technomathematics: Specialisation III. Engineering Science: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory</p>			

Course L0280: High-Order FEM	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	<ol style="list-style-type: none"> 1. Introduction 2. Motivation 3. Hierarchic shape functions 4. Mapping functions 5. Computation of element matrices, assembly, constraint enforcement and solution 6. Convergence characteristics 7. Mechanical models and finite elements for thin-walled structures 8. Computation of thin-walled structures 9. Error estimation and hp-adaptivity 10. High-order fictitious domain methods
Literature	<p>[1] Alexander Düster, High-Order FEM, Lecture Notes, Technische Universität Hamburg-Harburg, 164 pages, 2014</p> <p>[2] Barna Szabo, Ivo Babuska, Introduction to Finite Element Analysis – Formulation, Verification and Validation, John Wiley & Sons, 2011</p>

Course L0281: High-Order FEM	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Alexander Düster
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0805: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)				
Courses				
Title		Typ	Hrs/wk	CP
Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics) (L0516)		Lecture	2	3
Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics) (L0518)		Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students possess an in-depth knowledge in acoustics regarding acoustic waves, noise protection, and psycho acoustics and are able to give an overview of the corresponding theoretical and methodical basis.			
Skills	The students are capable to handle engineering problems in acoustics by theory-based application of the demanding methodologies and measurement procedures treated within the module.			
Personal Competence				
Social Competence	Students can work in small groups on specific problems to arrive at joint solutions.			
Autonomy	The students are able to independently solve challenging acoustical problems in the areas treated within the module. Possible conflicting issues and limitations can be identified and the results are critically scrutinized.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			
Course L0516: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)				
Typ	Lecture			
Hrs/wk	2			
CP	3			
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28			
Lecturer	Prof. Otto von Estorff			
Language	EN			
Cycle	SoSe			
Content	<ul style="list-style-type: none">- Introduction and Motivation- Acoustic quantities- Acoustic waves- Sound sources, sound radiation- Sound energy and intensity- Sound propagation- Signal processing- Psycho acoustics- Noise- Measurements in acoustics			
Literature	Cremer, L.; Heckl, M. (1996): Körperschall. Springer Verlag, Berlin Veit, I. (1988): Technische Akustik. Vogel-Buchverlag, Würzburg Veit, I. (1988): Flüssigkeitsschall. Vogel-Buchverlag, Würzburg			

Course L0518: Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics)	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0807: Boundary Element Methods				
Courses				
Title	Typ		Hrs/wk	CP
Boundary Element Methods (L0523)	Lecture		2	3
Boundary Element Methods (L0524)	Recitation Section (large)		2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous Knowledge	Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> The students possess an in-depth knowledge regarding the derivation of the boundary element method and are able to give an overview of the theoretical and methodical basis of the method.</p> <p><i>Skills</i> The students are capable to handle engineering problems by formulating suitable boundary elements, assembling the corresponding system matrices, and solving the resulting system of equations.</p> <p>Personal Competence</p> <p><i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions.</p> <p><i>Autonomy</i> The students are able to independently solve challenging computational problems and develop own boundary element routines. Problems can be identified and the results are critically scrutinized.</p>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	No	20 %	Midterm	
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Energy Systems: Core Qualification: Elective Compulsory Mechanical Engineering and Management: Specialisation Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Simulation Technology: Elective Compulsory			

Course L0523: Boundary Element Methods	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - Boundary value problems - Integral equations - Fundamental Solutions - Element formulations - Numerical integration - Solving systems of equations (statics, dynamics) - Special BEM formulations - Coupling of FEM and BEM - Hands-on Sessions (programming of BE routines) - Applications
Literature	Gaul, L.; Fiedler, Ch. (1997): Methode der Randelemente in Statik und Dynamik. Vieweg, Braunschweig, Wiesbaden Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

Course L0524: Boundary Element Methods	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1164: Practical Course Product Development, Materials and Production			
Courses			
Title	Typ	Hrs/wk	CP
Practical Course Product Development, Materials and Production (L1566)	Practical Course	6	6
Module Responsible	Prof. Wolfgang Hintze		
Admission Requirements	None		
Recommended Previous Knowledge	<p>Product Development:</p> <ul style="list-style-type: none"> Lectures: Mechanics I-III Lectures: Integrated Product Development I incl. CAD practical training <p>Materials:</p> <ul style="list-style-type: none"> Lectures: Structural Metallic Materials, Metallic Materials for Aircraft Applications, Introduction to Materials Testing Lectures: Structure and Properties of Polymers, Structure and Properties of Composites, Manufacturing of Polymers and Composites <p>Production:</p> <ul style="list-style-type: none"> Lecture: Production Engineering Lectures: Forming and Cutting Technology, Methods of production process design Lectures: Machine Tools and Robotic 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	<p>Students can ...</p> <ul style="list-style-type: none"> represent more complex context of different fields of study. describe functionality of modern measurement instrumentations and machine technologies. 		
<i>Skills</i>	<p>Students are capable of ...</p> <ul style="list-style-type: none"> applying theoretical knowledge for practical applications. applying provided experimental methods for examining contexts of different fields of study. analyzing and evaluating experimental results by using provided methods. applying modern measurement instrumentations. 		
Personal Competence			
<i>Social Competence</i>	<p>Students can ...</p> <ul style="list-style-type: none"> carry out and document experimental work in groups. present and discuss experimental results in mixed teams of different fields of study. 		
<i>Autonomy</i>	<p>Students are able to ...</p> <ul style="list-style-type: none"> carry out parts of experimental work independently guided by teachers. choose and apply suitable instruments. assess own strengths and weaknesses. 		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written elaboration		
Examination duration and scale			
Assignment for the Following Curricula	<p>Biomedical Engineering: Core Qualification: Compulsory</p> <p>Product Development, Materials and Production: Core Qualification: Compulsory</p>		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1566: Practical Course Product Development, Materials and Production	
Typ	Practical Course
Hrs/wk	6
CP	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Prof. Wolfgang Hintze, Prof. Bodo Fiedler, Prof. Claus Emmelmann, Prof. Dieter Krause, Prof. Gerold Schneider, Prof. Hermann Lödging, Prof. Jörg Weißmüller, Prof. Josef Schlattmann, Prof. Michael Morlock, Prof. Otto von Estorff, Prof. Thorsten Schüppstuhl, Prof. Uwe Weltin
Language	DE
Cycle	SoSe
Content	<p>Product Development:</p> <ul style="list-style-type: none"> • Modal analysis - experimental and computational • Appropriate design in engineering • Characterization of rubbery-elastic materials • Stick-Slip-Analysis at friction and wear test station <p>Materials:</p> <ul style="list-style-type: none"> • Property profiles of steel • Actuators for modern fuel injection systems - synthesis and properties • Processing, properties and structure of thermoplastic polymers and its composites • Tribology in joints <p>Production:</p> <ul style="list-style-type: none"> • Optimization of welding process parameters for hybrid plasma laser welding • Evaluation of stock removal processes • Analysis of basic laws in production logistics • Analysis of positioning behaviour and trajectory accuracy of industrial robots
Literature	Nach Themenstellung / depending on topic

Module M0752: Nonlinear Dynamics				
Courses				
Title	Typ		Hrs/wk	CP
Nonlinear Dynamics (L0702)	Integrated Lecture		4	6
Module Responsible	Prof. Norbert Hoffmann			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> • Calculus • Linear Algebra • Engineering Mechanics 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> Students are able to reflect existing terms and concepts in Nonlinear Dynamics and to develop and research new terms and concepts.</p> <p><i>Skills</i> Students are able to apply existing methods and procedures of Nonlinear Dynamics and to develop novel methods and procedures.</p> <p><i>Personal Competence</i></p> <p><i>Social Competence</i> Students can reach working results also in groups.</p> <p><i>Autonomy</i> Students are able to approach given research tasks individually and to identify and follow up novel research tasks by themselves.</p>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	2 Hours			
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory Mechanical Engineering and Management: Specialisation Mechatronics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory			

Course L0702: Nonlinear Dynamics	
Typ	Integrated Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Norbert Hoffmann
Language	DE/EN
Cycle	SoSe
Content	Fundamentals of Nonlinear Dynamics.
Literature	S. Strogatz: Nonlinear Dynamics and Chaos. Perseus, 2013.

Module M1339: Design optimization and probabilistic approaches in structural analysis			
Courses			
Title	Typ	Hrs/wk	CP
Design Optimization and Probabilistic Approaches in Structural Analysis (L1873)	Lecture	2	3
Design Optimization and Probabilistic Approaches in Structural Analysis (L1874)	Recitation Section (large)	2	3
Module Responsible	Prof. Benedikt Kriegesmann		
Admission Requirements	None		
Recommended Previous Knowledge	<ul style="list-style-type: none"> • Technical mechanics • Higher math 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> • Design optimization <ul style="list-style-type: none"> ◦ Gradient based methods ◦ Genetic algorithms ◦ Optimization with constraints ◦ Topology optimization • Reliability analysis <ul style="list-style-type: none"> ◦ Stochastic basics ◦ Monte Carlo methods ◦ Semi-analytic approaches • robust design optimization <ul style="list-style-type: none"> ◦ Robustness measures ◦ Coupling of design optimization and reliability analysis <i>Skills</i> <ul style="list-style-type: none"> • Application of optimization algorithms and probabilistic methods in the design of structures • Programming with Matlab • Implementation of algorithms • Debugging Personal Competence <i>Social Competence</i> <ul style="list-style-type: none"> • Team work • Oral explanation of the the work <i>Autonomy</i> <ul style="list-style-type: none"> • Application of methods learned in the framework of a home work • Familiarizing with source code provided • Description of approaches and results 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written elaboration		
Examination duration and scale	10 pages		
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory		

Course L1873: Design Optimization and Probabilistic Approaches in Structural Analysis	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe
Content	<p>In the course the theoretic basics for design optimization and reliability analysis are taught, where the focus is on the application of such methods. The lectures will consist of presentations as well as computer exercises. In the computer exercises, the methods learned will be implemented in Matlab for understanding the practical realization.</p> <p>The following contents will be considered:</p> <ul style="list-style-type: none"> • Design optimization <ul style="list-style-type: none"> ◦ Gradient based methods ◦ Genetic algorithms ◦ Optimization with constraints ◦ Topology optimization • Reliability analysis <ul style="list-style-type: none"> ◦ Stochastic basics ◦ Monte Carlo methods ◦ Semi-analytic approaches • robust design optimization <ul style="list-style-type: none"> ◦ Robustness measures ◦ Coupling of design optimization and reliability analysis
Literature	<p>[1] Arora, Jasbir. Introduction to Optimum Design. 3rd ed. Boston, MA: Academic Press, 2011.</p> <p>[2] Haldar, A., and S. Mahadevan. Probability, Reliability, and Statistical Methods in Engineering Design. John Wiley & Sons New York/Chichester, UK, 2000.</p>

Course L1874: Design Optimization and Probabilistic Approaches in Structural Analysis	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann
Language	DE
Cycle	SoSe
Content	Matlab exercises complementing the lecture
Literature	siehe Vorlesung

Module M0806: Technical Acoustics II (Room Acoustics, Computational Methods)				
Courses				
Title		Typ	Hrs/wk	CP
Technical Acoustics II (Room Acoustics, Computational Methods) (L0519)		Lecture	2	3
Technical Acoustics II (Room Acoustics, Computational Methods) (L0521)		Recitation Section (large)	2	3
Module Responsible	Prof. Otto von Estorff			
Admission Requirements	None			
Recommended Previous Knowledge	Technical Acoustics I (Acoustic Waves, Noise Protection, Psycho Acoustics) Mechanics I (Statics, Mechanics of Materials) and Mechanics II (Hydrostatics, Kinematics, Dynamics) Mathematics I, II, III (in particular differential equations)			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<i>Knowledge</i> The students possess an in-depth knowledge in acoustics regarding room acoustics and computational methods and are able to give an overview of the corresponding theoretical and methodical basis. <i>Skills</i> The students are capable to handle engineering problems in acoustics by theory-based application of the demanding computational methods and procedures treated within the module. <i>Personal Competence</i> <i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions. <i>Autonomy</i> The students are able to independently solve challenging acoustical problems in the areas treated within the module. Possible conflicting issues and limitations can be identified and the results are critically scrutinized.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and scale	20-30 Minuten			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Course L0519: Technical Acoustics II (Room Acoustics, Computational Methods)	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> - Room acoustics - Sound absorber - Standard computations - Statistical Energy Approaches - Finite Element Methods - Boundary Element Methods - Geometrical acoustics - Special formulations - Practical applications - Hands-on Sessions: Programming of elements (Matlab)
Literature	Cremer, L.; Heckl, M. (1996): Körperschall. Springer Verlag, Berlin Veit, I. (1988): Technische Akustik. Vogel-Buchverlag, Würzburg Veit, I. (1988): Flüssigkeitsschall. Vogel-Buchverlag, Würzburg Gaul, L.; Fiedler, Ch. (1997): Methode der Randelemente in Statik und Dynamik. Vieweg, Braunschweig, Wiesbaden Bathe, K.-J. (2000): Finite-Elemente-Methoden. Springer Verlag, Berlin

Course L0521: Technical Acoustics II (Room Acoustics, Computational Methods)	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Otto von Estorff
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1140: Technical Complementary Course Core Studies for PEPMS (according to Subject Specific Regulations)			
Courses			
Title	Typ	Hrs/wk	CP
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	See selected module according to FSPO		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	see selected module according to FSPO		
<i>Knowledge</i>			
<i>Skills</i>			
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>	see selected module according to FSPO		
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Product Development, Materials and Production: Core Qualification: Elective Compulsory		

Module M1184: Research Project Product Development, Materials and Production				
Courses				
Title	Typ		Hrs/wk	CP
Module Responsible	Dozenten des Studiengangs			
Admission Requirements	None			
Recommended Previous Knowledge	Subjects of the Master program and the chosen specialisation.			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	<ul style="list-style-type: none"> Students can explain the project as well as their autonomously gained knowledge and relate it to current issues of their field of study. They can explain the basic scientific methods they have worked with. 			
<i>Skills</i>	The students are able to autonomously solve a limited scientific task under the guidance of an experienced researcher. They can justify and explain their approach for problem solving; they can draw conclusions from their results, and then can find new ways and methods for their work. Students are capable of comparing and assessing alternative approaches with their own with regard to given criteria.			
Personal Competence <i>Social Competence</i>	The students are able to condense the relevance and the structure of the project work, the work procedure and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their peers and supervisors.			
<i>Autonomy</i>	The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.			
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0			
Credit points	12			
Course achievement	None			
Examination	Study work			
Examination duration and scale	according to FSPO			
Assignment for the Following Curricula	Product Development, Materials and Production: Core Qualification: Compulsory			

Module M0763: Aircraft Energy Systems (FS1)

Courses			
Title	Typ	Hrs/wk	CP
Aircraft Systems I (L0735)	Lecture	3	4
Aircraft Systems I (L0739)	Recitation Section (large)	2	2
Module Responsible	Prof. Frank Thielecke		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Hydraulics • Control Systems 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	Students are able to: <ul style="list-style-type: none"> • Describe essential components and design points of hydraulic, electrical and high-lift systems • Give an overview of the functionality of air conditioning systems • Explain the need for high-lift systems such as ist functionality and effects • Assess the challenge during the design of supply systems of an aircraft 		
<i>Skills</i>	Students are able to: <ul style="list-style-type: none"> • Design hydraulic and electric supply systems of aircrafts • Design high-lift systems of aircrafts • Analyze the thermodynamic behaviour of air conditioning systems 		
Personal Competence <i>Social Competence</i>	Students are able to: <ul style="list-style-type: none"> • Perform system design in groups and present and discuss results 		
<i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • Reflect the contents of lectures autonomously 		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	165 Minutes		
Assignment for the Following Curricula	Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L0735: Aircraft Systems I	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> Hydraulic Energy Systems (Fluids; pressure loss in valves and pipes; components of hydraulic systems like pumps, valves, etc.; pressure/flow characteristics; actuators; tanks; power and heat balances; emergency power) Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis) High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices) Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)
Literature	<ul style="list-style-type: none"> Moir, Seabridge: Aircraft Systems Green: Aircraft Hydraulic Systems Torenbek: Synthesis of Subsonic Airplane Design SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes

Course L0739: Aircraft Systems I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1024: Methods of Integrated Product Development			
Courses			
Title	Typ	Hrs/wk	CP
Integrated Product Development II (L1254)	Lecture	3	3
Integrated Product Development II (L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge of Integrated product development and applying CAE systems		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	After passing the module students are able to: <ul style="list-style-type: none"> • explain technical terms of design methodology, • describe essential elements of construction management, • describe current problems and the current state of research of integrated product development. 		
<i>Skills</i>	After passing the module students are able to: <ul style="list-style-type: none"> • select and apply proper construction methods for non-standardized solutions of problems as well as adapt new boundary conditions, • solve product development problems with the assistance of a workshop based approach, • choose and execute appropriate moderation techniques. 		
Personal Competence			
<i>Social Competence</i>	After passing the module students are able to: <ul style="list-style-type: none"> • prepare and lead team meetings and moderation processes, • work in teams on complex tasks, • represent problems and solutions and advance ideas. 		
<i>Autonomy</i>	After passing the module students are able to: <ul style="list-style-type: none"> • give a structured feedback and accept a critical feedback, • implement the accepted feedback autonomous. 		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Course achievement	None		
Examination	Oral exam		
Examination duration and scale	30 Minuten		
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L1254: Integrated Product Development II	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	<p>Lecture</p> <p>The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.</p> <p>Topics of the course include in particular:</p> <ul style="list-style-type: none"> • Methods of product development, • Presentation techniques, • Industrial Design, • Design for variety • Modularization methods, • Design catalogs, • Adapted QFD matrix, • Systematic material selection, • Assembly oriented design, <p>Construction management</p> <ul style="list-style-type: none"> • CE mark, declaration of conformity including risk assessment, • Patents, patent rights, patent monitoring • Project management (cost, time, quality) and escalation principles, • Development management for mechatronics, • Technical Supply Chain Management. <p>Exercise (PBL)</p> <p>In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.</p> <p>Students learn an independently moderated and workshop based approach through industry related practice examples to solve complex and currently existing issues in product development. They will learn the ability to apply important methods of product development and design management autonomous and acquire further expertise in the field of integrated product development. Besides personal skills, such as teamwork, guiding discussions and representing work results will be acquired through the workshop based structure of the event under its own planning and management.</p>
Literature	<ul style="list-style-type: none"> • Andreassen, M.M., Design for Assembly, Berlin, Springer 1985. • Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. • Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. • Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007. • Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006. • Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000. • Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York, Springer 2013.

Course L1255: Integrated Product Development II	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1025: Fluidics				
Courses				
Title			Typ	Hrs/wk CP
Fluidics (L1256)			Lecture	2 3
Fluidics (L1371)			Project-/problem-based Learning	1 2
Fluidics (L1257)			Recitation Section (large)	1 1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	Good knowledge of mechanics (stereo statics, elastostatics, hydrostatics, kinematics and kinetics), fluid mechanics, and engineering design			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	After passing the module students are able to <ul style="list-style-type: none"> explain structures and functionalities of hydrostatic, pneumatic, and hydrodynamic components, explain the interaction of hydraulic components in hydraulic systems, explain open and closed loop control of hydraulic systems, describe functioning and applications of hydrodynamic torque converters, brakes and clutches as well as centrifugal pumps and aggregates in plant technology 			
<i>Skills</i>	After passing the module students are able to <ul style="list-style-type: none"> analyse and assess hydraulic and pneumatic components and systems, design and dimension hydraulic systems for mechanical applications, perform numerical simulations of hydraulic systems based on abstract problem definitions, select and adapt pump characteristic curves for hydraulic systems dimension hydrodynamic torque converters and brakes for mechanical aggregates. 			
Personal Competence				
<i>Social Competence</i>	After passing the module students are able to <ul style="list-style-type: none"> discuss and present functional context in groups, organise teamwork autonomously. 			
<i>Autonomy</i>	After passing the module students are able to <ul style="list-style-type: none"> obtain necessary knowledge for the simulation. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	None	Attestation	Simulation hydrostatischer Systeme
Examination	Written exam			
Examination duration and scale	90			
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1256: Fluidics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	<p>Lecture</p> <p>Hydrostatics</p> <ul style="list-style-type: none"> • physical fundamentals • hydraulic fluids • hydrostatic machines • valves • components • hydrostatic transmissions • examples from industry <p>Pneumatics</p> <ul style="list-style-type: none"> • generation of compressed air • pneumatic motors • Examples of use <p>Hydrodynamics</p> <ul style="list-style-type: none"> • physical fundamentals • hydraulic continuous-flow machines • hydrodynamic transmissions • interoperation of motor and transmission <p>Exercise</p> <p>Hydrostatics</p> <ul style="list-style-type: none"> • reading and design of hydraulic diagrams • dimensioning of hydrostatic traction and working drives • performance calculation <p>Hydrodynamics</p> <ul style="list-style-type: none"> • calculation / dimensioning of hydrodynamic torque converters • calculation / dimensioning of centrifugal pumps • creating and reading of characteristic curves of pumps and systems <p>Field trip</p> <ul style="list-style-type: none"> • field trip to a regional company from the hydraulic industry. <p>Exercise</p> <p>Numerical simulation of hydrostatic systems</p> <ul style="list-style-type: none"> • getting to know a numerical simulation environment for hydraulic systems • transformation of a task into a simulation model • simulation of common components • variation of simulation parameters • using simulations for system dimensioning and optimisation • (partly) self-organised teamwork
Literature	<p>Bücher</p> <ul style="list-style-type: none"> • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011 • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006 • Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006 • Beitz, W., Grote, K.-H.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage <p>Skript zur Vorlesung</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1371: Fluidics	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1257: Fluidics	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1193: Cabin Systems Engineering			
Courses			
Title	Typ	Hrs/wk	CP
Computer and communication technology in cabin electronics and avionics (L1557)	Lecture	2	2
Computer and communication technology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1
Model-Based Systems Engineering (MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	3	3
Module Responsible	Prof. Ralf God		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems Previous knowledge in: <ul style="list-style-type: none"> • Systems Engineering 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • describe the structure and operation of computer architectures • explain the structure and operation of digital communication Networks • explain architectures of cabin electronics, integrated modular avionics (IMA) and Aircraft Data Communication Network (ADCN) • understand the approach of Model-Based Systems Engineering (MBSE) in the design of hardware and software-based cabin systems Students are able to: <ul style="list-style-type: none"> • understand, operate and maintain a Minicomputer • build up a network communication and communicate with other network participants • connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network • model system functions by means of formal languages SysML/UML and generate software code from the models • execute software code on a minicomputer Students are able to: <ul style="list-style-type: none"> • elaborate partial results and merge with others to form a complete solution Students are able to: <ul style="list-style-type: none"> • organize and schedule their practical tasks 		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 minutes		
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L1557: Computer and communication technology in cabin electronics and avionics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

Course L1558: Computer and communication technology in cabin electronics and avionics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

Course L1551: Model-Based Systems Engineering (MBSE) with SysML/UML	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	<p>Objectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages SysML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based Systems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):</p> <ul style="list-style-type: none"> • What is a model? • What is Systems Engineering? • Survey of MBSE methodologies • The modelling languages SysML /UML • Tools for MBSE • Best practices for MBSE • Requirements specification, functional architecture, specification of a solution • From model to software code • Validation and verification: XIL methods • Accompanying MBSE project
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - Weillkiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008 - Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

Module M0511: Electricity Generation from Wind and Hydro Power			
Courses			
Title	Typ	Hrs/wk	CP
Sustainability Management (L0007)	Lecture	2	1
Hydro Power Use (L0013)	Lecture	1	1
Wind Turbine Plants (L0011)	Lecture	2	3
Wind Energy Use - Focus Offshore (L0012)	Lecture	1	1
Module Responsible	Dr. Isabel Höfer		
Admission Requirements	None		
Recommended Previous Knowledge	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II, Module: Fundamentals of Fluid Mechanics		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedure in the implementation of renewable energy projects in countries outside Europe.</p> <p>Through active discussions of various topics within the seminar of the module, students improve their understanding and the application of the theoretical background and are thus able to transfer what they have learned in practice.</p> <p>Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate and assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can in compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects.</p> <p>Students can discuss scientific tasks subject-specificly and multidisciplinary within a seminar.</p> <p>Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of the lecture and to acquire the particular knowledge about the subject area.</p>		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	2.5 hours written exam + Presentation in sustainability management		
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory		

Course L0007: Sustainability Management	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	WiSe
Content	<p>The lecture sustainability management provide an insight into the various aspects and dimensions of sustainability. This content of the course is based on the foundations of environmental assessment; therefore the previous attendance of the lecture environmental assessment is recommended. Various valuation approaches for assessing environmental, economic and social aspects are presented. Their application and use for a sustainability management's discussion is explained by means of short technology examples and is later comprehensively presented through case examples.</p> <ul style="list-style-type: none"> • Introduction to the topic of sustainability • Dimensions of sustainability: <ul style="list-style-type: none"> ◦ ecology ◦ economics ◦ social • Transition from the environmental assessment for sustainability management • Case Studies • Excursion <p>Objective: The aim of the course is to learn methods for the assessment of sustainability aspects and apply for sustainability management.</p>
Literature	<p>Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage</p> <p>Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.</p>

Course L0013: Hydro Power Use	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner, Hugo Götsch
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Introduction, importance of water power in the national and global context • Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies • Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems • Construction of hydroelectric power plants: description of the individual components and their technical system interaction • Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. • Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection • Hydropower and the Environment • Examples from practice
Literature	<ul style="list-style-type: none"> • Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage • Quaschnig, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage • Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage • von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage • Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0011: Wind Turbine Plants	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rudolf Zellermann, Dr. Jochen Oexmann
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Historical development • Wind: origins, geographic and temporal distribution, locations • Power coefficient, rotor thrust • Aerodynamics of the rotor • Operating performance • Power limitation, partial load, pitch and stall control • Plant selection, yield prediction, economy • Excursion
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005

Course L0012: Wind Energy Use - Focus Offshore	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering • Physical fundamentals for utilization of wind energy • Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships • Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures • Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection • Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics • Development and planning of offshore wind farms • Operation and optimization of offshore wind farms • Day excursion
Literature	<ul style="list-style-type: none"> • Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage • Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidelberg, 1997, 3. Auflage • Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4. Auflage • Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage • Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

Module M0630: Robotics and Navigation in Medicine								
Courses								
Title	Typ		Hrs/wk	CP				
Robotics and Navigation in Medicine (L0335)	Lecture		2	3				
Robotics and Navigation in Medicine (L0338)	Project Seminar		2	2				
Robotics and Navigation in Medicine (L0336)	Recitation Section (small)		1	1				
Module Responsible	Prof. Alexander Schlaefer							
Admission Requirements	None							
Recommended Previous Knowledge	<ul style="list-style-type: none">• principles of math (algebra, analysis/calculus)• principles of programming, e.g., in Java or C++• solid R or Matlab skills							
Educational Objectives	After taking part successfully, students have reached the following learning results							
Professional Competence	<div><div>Knowledge</div><div>The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.</div></div> <div><div>Skills</div><div>The students are able to design and evaluate navigation systems and robotic systems for medical applications.</div></div> <div><div>Personal Competence</div><div><div>Social Competence</div><div>The students discuss the results of other groups, provide helpful feedback and can incorporate feedback into their work.</div></div><div><div>Autonomy</div><div>The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.</div></div></div>							
Workload in Hours					Independent Study Time 110, Study Time in Lecture 70			
Credit points					6			
Course achievement					Compulsory	Bonus	Form	Description
					Yes	10 %	Written elaboration	
	Yes	10 %	Presentation					
Examination	Written exam							
Examination duration and scale	90 minutes							
Assignment for the Following Curricula	<div>Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory</div> <div>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory</div> <div>International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory</div> <div>International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory</div> <div>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</div> <div>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory</div> <div>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory</div> <div>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory</div> <div>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory</div> <div>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</div> <div>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</div> <div>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</div> <div>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</div> <div>Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory</div>							

Course L0335: Robotics and Navigation in Medicine	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - kinematics - calibration - tracking systems - navigation and image guidance - motion compensation <p>The seminar extends and complements the contents of the lecture with respect to recent research results.</p>
Literature	<p>Spong et al.: Robot Modeling and Control, 2005</p> <p>Troccaz: Medical Robotics, 2012</p> <p>Further literature will be given in the lecture.</p>

Course L0338: Robotics and Navigation in Medicine	
Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0336: Robotics and Navigation in Medicine	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0764: Flight Control Systems (FS2)				
Courses				
Title			Typ	
Aircraft Systems II (L0736)			Lecture	3
Aircraft Systems II (L0740)			Recitation Section (large)	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	basic knowledge of: <ul style="list-style-type: none"> • mathematics • mechanics • thermo dynamics • electronics • fluid technology • control technology 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students are able to... <ul style="list-style-type: none"> • describe the structure of primary flight control systems as well as actuation-, avionic-, high lift systems in general along with corresponding properties and applications. • explain different configurations and designs and their origins • 			
<i>Skills</i>	Students are able to... <ul style="list-style-type: none"> • size primary flight control actuation systems • perform a controller design process for the flight control actuators • design high-lift kinematics 			
Personal Competence				
<i>Social Competence</i>	Students are able to: <ul style="list-style-type: none"> • Develop joint solutions in mixed teams 			
<i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • derive requirements and perform appropriate yet simplified design processes for aircraft systems from complex issues and circumstances in a self-reliant manner 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	165 Minutes			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0736: Aircraft Systems II	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems) • Flight Control Systems (control surfaces, hinge moments; requirements of stability and controllability, actuation power; principles of reversible and irreversible flight control systems; servo actuation systems) • Landing Gear Systems (Configurations and geometries; analysis of landing gear systems with respect to damper dynamics, dynamics of the breaking aircraft and power consumption; design and analysis of breaking systems with respect to energy and heat; anti-skid systems) • Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank) • De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)
Literature	<ul style="list-style-type: none"> • Moir, Seabridge: Aircraft Systems • Torenbek: Synthesis of Subsonic Airplane Design • Curry: Aircraft Landing Gear Design: Principles and Practices

Course L0740: Aircraft Systems II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0811: Medical Imaging Systems			
Courses			
Title	Typ	Hrs/wk	CP
Medical Imaging Systems (L0819)	Lecture	4	6
Module Responsible	Dr. Michael Grass		
Admission Requirements	None		
Recommended Previous Knowledge	none		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	<p>Students can:</p> <ul style="list-style-type: none"> Describe the system configuration and components of the main clinical imaging systems; Explain how the system components and the overall system of the imaging systems function; Explain and apply the physical processes that make imaging possible and use with the fundamental physical equations; Name and describe the physical effects required to generate image contrasts; Explain how spatial and temporal resolution can be influenced and how to characterize the images generated; Explain which image reconstruction methods are used to generate images; <p>Describe and explain the main clinical uses of the different systems.</p>		
<i>Skills</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required; <ul style="list-style-type: none"> Calculate the parameters of imaging systems using the mathematical or physical equations; Determine the influence of different system components on the spatial and temporal resolution of imaging systems; Explain the importance of different imaging systems for a number of clinical applications; <p>Select a suitable imaging system for an application.</p>		
Personal Competence <i>Social Competence</i>	none		
<i>Autonomy</i>	<p>Students can:</p> <ul style="list-style-type: none"> Understand which physical effects are used in medical imaging; Decide independently for which clinical issue a measuring system can be used. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	<p>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory</p> <p>Biomedical Engineering: Core Qualification: Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory</p>		

Course L0819: Medical Imaging Systems	
Typ	Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Dr. Michael Grass, Dr. Sven Prevrhal, Dr. Tim Nielsen, Frank Michael Weber
Language	DE
Cycle	SoSe
Content	
Literature	<p>Primary book:</p> <p>1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press</p> <p>Secondary books:</p> <ul style="list-style-type: none"> - A. Webb, "Introduction to Biomedical Imaging", IEEE Press 2003. - W.R. Hendee and E.R. Ritenour, "Medical Imaging Physics", Wiley-Liss, New York, 2002. - H. Morneburg (Edt), "Bildgebende Systeme für die medizinische Diagnostik", Erlangen: Siemens Publicis MCD Verlag, 1995. - O. Dössel, "Bildgebende Verfahren in der Medizin", Springer Verlag Berlin, 2000.

Module M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)

Courses

Title	Typ	Hrs/wk	CP
Applied Automation (L1592)	Project-/problem-based Learning	3	3
Ergonomics (L0653)	Lecture	2	3
Elements of Integrated Production Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
Innovation and Product Management (L2168)	Seminar	2	3
Lightweight Design Practical Course (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Processes of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Technology (L0664)	Lecture	2	3
Six Sigma (L1130)	Lecture	2	3
Structural Mechanics of Fibre Reinforced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Ceramics Technology (L0379)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics (L0176)	Lecture	2	2
Reliability in Engineering Dynamics (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L0749)	Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of product development, materials and production Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> - <i>Autonomy</i> <ul style="list-style-type: none"> Students are able to develop their knowledge and skills by autonomous election of courses. 			
Workload in Hours	Depends on choice of courses		
Credit points	12		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1592: Applied Automation	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> -Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy
Literature	<p>John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005</p> <p>Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010</p> <p>K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wiley & Sons, Inc., 1992</p>

Course L0653: Ergonomics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Armin Bossemeyer
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0927: Elements of Integrated Production Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	not available
Literature	<p>Harris, R.; Harris, C.; Wilson, E.: Making Materials Flow, Lean Enterprise Institute, Cambridge, 2003.</p> <p>Ohno, T.: Das Toyota-Produktionssystem, Campus-Verlag, Frankfurt et al, 1993.</p> <p>Rother, M.: Die Kata des Weltmarktführers. Toyotas Erfolgsmethoden, Campus-Verlag, Frankfurt et al, 2009.</p> <p>Rother, M.; Shook, J.: Sehen lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen, Lean Management Institut, Aachen, 2006.</p> <p>Rother, M.; Harris, R.: Creating Continuous Flow, Lean Enterprise Institute, Brookline, 2001.</p> <p>Shingo, S.: A Revolution in Manufacturing. The SMED System, Productivity Press, 2006.</p> <p>Womack, J. P. et al: Die zweite Revolution in der Autoindustrie, Frankfurt/New York, Campus Verlag, 1992.</p>

Course L1512: Development Management for Mechatronics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Johannes Nicolas Gebhardt, Dr. Daniel Steffen
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Processes and methods of product development - from idea to market launch <ul style="list-style-type: none"> identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development <ul style="list-style-type: none"> Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	<ul style="list-style-type: none"> Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

Course L0310: Fatigue & Damage Tolerance	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Martin Flamm
Language	EN
Cycle	WiSe
Content	Design principles, fatigue strength, crack initiation and crack growth, damage calculation, counting methods, methods to improve fatigue strength, environmental influences
Literature	Jaap Schijve, Fatigue of Structures and Materials. Kluwer Academic Publisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

Course L2012: Industry 4.0 for engineers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	120 min
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2168: Innovation and Product Management	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christoph Fuchs
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L1258: Lightweight Design Practical Course	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	<p>Development of a sandwich structure made of fibre reinforced plastics</p> <ul style="list-style-type: none"> • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion“, Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation“, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0950: Mechanisms, Systems and Processes of Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	<p>Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies</p> <ul style="list-style-type: none"> • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	<ul style="list-style-type: none"> • E. Macherauch: Praktikum in Werkstoffkunde, Vieweg • G. E. Dieter: Mechanical Metallurgy, McGraw-Hill • R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg • R. Bürgel: Werkstoffe sicher beurteilen und richtig einsetzen, Vieweg

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0724: Microsystems Technology	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction (historical view, scientific and economic relevance, scaling laws) • Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) • Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) • Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) • Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) • Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) • Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) • Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) • Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics) • MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration) • Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship) • System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	<p>M. Madou: Fundamentals of Microfabrication, CRC Press, 2002</p> <p>N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009</p> <p>T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010</p> <p>G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0928: Productivity Management	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Principles of productivity management • Shop floor management and standardisation • Takt analysis and design of manual operations • Maintenance Principles • Total Productive Maintenance (TPM) • Optimisation of set-up operations • Analysis of interlinked production systems
Literature	<p>Bokranz, R.; Landau, K.: Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.</p> <p>Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.</p> <p>Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.</p> <p>Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985</p>

Course L0931: Productivity Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0664: Feedback Control in Medical Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	<p>Always viewed from the engineer's point of view, the lecture is structured as follows:</p> <ul style="list-style-type: none"> • Introduction to the topic • Fundamentals of physiological modelling • Introduction to Breathing and Ventilation • Physiology and Pathology in Cardiology • Introduction to the Regulation of Blood Glucose • kidney function and renal replacement therapy • Representation of the control technology on the concrete ventilator • Excursion to a medical technology company <p>Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.</p>
Literature	<ul style="list-style-type: none"> • Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. • Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. • Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Course L1130: Six Sigma	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Claus Emmelmann
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction and structuring • Basic terms of quality management • Measuring and inspection equipment • Tools of quality management: FMEA, QFD, FTA, etc. • Quality management methodology Six Sigma, DMAIC
Literature	<p>Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008</p> <p>Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996</p> <p>Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008</p>

Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	<p>Classical laminate theory</p> <p>Rules of mixture</p> <p>Failure mechanisms and criteria of composites</p> <p>Boundary value problems of isotropic and anisotropic shells</p> <p>Stability of composite structures</p> <p>Optimization of laminated composites</p> <p>Modelling composites in FEM</p> <p>Numerical multiscale analysis of textile composites</p> <p>Progressive failure analysis</p>
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, aktuelle Auflage. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, , aktuelle Auflage. • Reddy, J.N., „Mechanics of Composite Laminated Plates and Shells“, CRC Publishing, Boca Raton et al., current edition. • Jones, R.M., „Mechanics of Composite Materials“, Scripta Book Co., Washington, current edition. • Timoshenko, S.P., Gere, J.M., „Theory of elastic stability“, McGraw-Hill Book Company, Inc., New York, current edition. • Turvey, G.J., Marshall, I.H., „Buckling and postbuckling of composite plates“, Chapman and Hall, London, current edition. • Herakovich, C.T., „Mechanics of fibrous composites“, John Wiley and Sons, Inc., New York, current edition. • Mittelstedt, C., Becker, W., „Strukturmechanik ebener Lamine“, aktuelle Auflage.

Course L1820: System Simulation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	<p>Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica.</p> <ul style="list-style-type: none"> • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	<p>[1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7</p> <p>[2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014.</p> <p>[3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</p> <p>[4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</p> <p>[5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1821: System Simulation	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Basics with analysis, concept, proposal drawings and sketches • Samples from practice of technical industrial design • Product concept with new ideas and package • ID proposal with structural concept and external product ergonomics • Visualisation and presentation of the overall concept • Realization as individual case studies
Literature	<p>Literatur über technisches Produktdesign</p> <p>Technisches Rendering und Präsentation</p> <p>Zeichnen und perspektivisches Entwerfen</p> <p>Literaturhinweise</p> <p>What is Product Design ?</p> <p>Laura Slack</p> <p>RotoVision Schweiz 2006</p> <p>Product Design Now</p> <p>Design and Scetches</p> <p>CollinsDesign and maomao publications Spanien 2006</p> <p>Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects,</p> <p>Watson, Gupta Publications,a division of Billboard Publications Inc.,</p> <p>New York 1983</p> <p>Creative Techniques</p> <p>DRAWING</p> <p>Barons Educational Series</p> <p>ISBN-13: 978-0-7641-6182-7</p> <p>Joseph Ungar, Rendering In Mixed Media - Techniques for Concept</p> <p>Presentation for Designers and Illustrators</p> <p>Watson-Guptil Publication a division of Billboard Publications Inc.,</p> <p>New York 1985</p> <p>AIRWORLD</p> <p>Design und Architektur für die Flugreise</p> <p>Vitra Design Stiftung Weil am Rhein 2004</p>

	<p>Airline Design</p> <p>Perter Deslius Jacek Slaski te Neues 2005</p> <p>Technik und Sicherheit von Passagierflugzeugen</p> <p>Frank Littek</p> <p>Motorbuch Verlag 2003</p> <p>Jetliner Cabins</p> <p>Jennifer Coutts Clay</p> <p>Cs books England 2006</p> <p>BOEING Widebodies</p> <p>Michael Haenggi motorbooks international USA 2003</p> <p>form - Zeitschrift für Gestaltung, Verlag form GmbH,</p> <p>Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim</p> <p>(erscheint vierteljährlich, Verlag form GmbH)</p> <p>design report</p> <p>german magasin,</p> <p>(erscheint monatlich)</p> <p>md - möbel interior design, Konradin-Verlag</p> <p>Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen</p> <p>(erscheint monatlich)</p> <p>CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,</p> <p>Kitashinjuku, Shinjuku-ku, Tokio 160, Japan</p> <p>(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,</p> <p>Auto & Design,</p> <p>Corso Frabcia 161, 10139 Torino, Italia</p> <p>(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei</p> <p>Monate , erhältlich am HBF Hamburg</p> <p>AERO International,</p> <p>Magazin für Zivilluftfahrt</p> <p>(erscheint monatlich)</p> <p>Aircraft interior international</p> <p>Engl. magasin for Aircraft cabin interior</p> <p>(erscheint 2 monatlich)</p> <p>aerotec</p> <p>Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie</p>
--	---

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0379: Ceramics Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Rolf Janßen
Language	DE/EN
Cycle	WiSe
Content	<p>Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metallurgical techniques and sintering (solid state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed. Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.</p> <p>Content:</p> <ol style="list-style-type: none"> 1. Introduction 2. Raw materials 3. Powder fabrication 4. Powder processing 5. Shape-forming processes 6. Densification, sintering 7. Glass and Cement technology 8. Ceramic-metal joining techniques <p>Inhalt:</p>
Literature	<p>W.D. Kingery, „Introduction to Ceramics“, John Wiley & Sons, New York, 1975</p> <p>ASM Engineering Materials Handbook Vol.4 „Ceramics and Glasses“, 1991</p> <p>D.W. Richerson, „Modern Ceramic Engineering“, Marcel Dekker, New York, 1992</p> <p>Skript zur Vorlesung</p>

Course L0949: Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	<p>Application and analysis of basic mechanical as well as non-destructive testing of materials</p> <ul style="list-style-type: none"> • Determination elastic constants • Tensile test • Fatigue test (testing with constant stress, strain, or plastic strain amplitude, low and high cycle fatigue, mean stress effect) • Crack growth upon static loading (stress intensity factor, fracture toughness) • Creep test • Hardness test • Charpy impact test • Non destructive testing
Literature	<p>E. Macherauch: Praktikum in Werkstoffkunde, Vieweg</p> <p>G. E. Dieter: Mechanical Metallurgy, McGraw-Hill</p>

Course L0176: Reliability in Engineering Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min.
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	<p>Method for calculation and testing of reliability of dynamic machine systems</p> <ul style="list-style-type: none"> • Modeling • System identification • Simulation • Processing of measurement data • Damage accumulation • Test planning and execution
Literature	<p>Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4</p> <p>Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737</p> <p>Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.</p> <p>VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412</p>

Course L1303: Reliability in Engineering Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0749: Reliability of Aircraft Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wieczorek
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Functions of reliability and safety (regulations, certification requirements) • Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment) • Reliability analysis of electrical and mechanical systems
Literature	<ul style="list-style-type: none"> • CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1156: Systems Engineering				
Courses				
Title	Typ		Hrs/wk	CP
Systems Engineering (L1547)	Lecture		3	4
Systems Engineering (L1548)	Recitation Section (large)		1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous Knowledge	<p>Basic knowledge in:</p> <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems <p>Previous knowledge in:</p> <ul style="list-style-type: none"> • Aircraft Cabin Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> • understand systems engineering process models, methods and tools for the development of complex Systems • describe innovation processes and the need for technology Management • explain the aircraft development process and the process of type certification for aircraft • explain the system development process, including requirements for systems reliability • identify environmental conditions and test procedures for airborne Equipment • value the methodology of requirements-based engineering (RBE) and model-based requirements engineering (MBRE) <p>Students are able to:</p> <ul style="list-style-type: none"> • plan the process for the development of complex Systems • organize the development phases and development Tasks • assign required business activities and technical Tasks • apply systems engineering methods and tools <p>Students are able to:</p> <ul style="list-style-type: none"> • understand their responsibilities within a development team and integrate themselves with their role in the overall process <p>Students are able to:</p> <ul style="list-style-type: none"> • interact and communicate in a development team which has distributed tasks 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes			
Assignment for the Following Curricula	<p>Aircraft Systems Engineering: Core Qualification: Compulsory</p> <p>International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory</p> <p>Mechatronics: Specialisation System Design: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory</p>			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1547: Systems Engineering	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	<p>The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known.</p> <p>Key aspects of the course are processes for innovation and technology management, system design, system integration and certification as well as tools and methods for systems engineering:</p> <ul style="list-style-type: none"> • Innovation processes • IP-protection • Technology management • Systems engineering • Aircraft program • Certification issues • Systems development • Safety objectives and fault tolerance • Environmental and operating conditions • Tools for systems engineering • Requirements-based engineering (RBE) • Model-based requirements engineering (MBRE)
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE) - Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010 - NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007 - Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010 - De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010 - Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt.Verlag, 2008

Course L1548: Systems Engineering	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1161: Turbomachinery				
Courses				
Title	Typ		Hrs/wk	CP
Turbomachines (L1562)	Lecture		3	4
Turbomachines (L1563)	Recitation Section (large)		1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous Knowledge	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	The students can <ul style="list-style-type: none"> distinguish the physical phenomena of conversion of energy, understand the different mathematic modelling of turbomachinery, calculate and evaluate turbomachinery. 			
<i>Skills</i>	The students are able to <ul style="list-style-type: none"> understand the physics of Turbomachinery, solve excersises self-consistent. 			
Personal Competence				
<i>Social Competence</i>	The students are able to <ul style="list-style-type: none"> discuss in small groups and develop an approach. 			
<i>Autonomy</i>	The students are able to <ul style="list-style-type: none"> develop a complex problem self-consistent, analyse the results in a critical way, have an qualified exchange with other students. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Marine Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			

Course L1562: Turbomachines	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Markus Schatz
Language	DE
Cycle	SoSe
Content	Topics to be covered will include: <ul style="list-style-type: none"> Application cases of turbomachinery Fundamentals of thermodynamics and fluid mechanics Design fundamentals of turbomachinery Introduction to the theory of turbine stage Design and operation of the turbocompressor Design and operation of the steam turbine Design and operation of the gas turbine Physical limits of the turbomachines
Literature	<ul style="list-style-type: none"> Traupel: Thermische Turbomaschinen, Springer. Berlin, Heidelberg, New York Bräunling: Flugzeuggasturbinen, Springer., Berlin, Heidelberg, New York Seume: Stationäre Gasturbinen, Springer., Berlin, Heidelberg, New York Menny: Strömungsmaschinen, Teubner., Stuttgart

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1563: Turbomachines	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Markus Schatz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)			
Courses			
Title	Typ	Hrs/wk	CP
Applied Automation (L1592)	Project-/problem-based Learning	3	3
Ergonomics (L0653)	Lecture	2	3
Elements of Integrated Production Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
Innovation and Product Management (L2168)	Seminar	2	3
Lightweight Design Practical Course (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Processes of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Technology (L0664)	Lecture	2	3
Six Sigma (L1130)	Lecture	2	3
Structural Mechanics of Fibre Reinforced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Ceramics Technology (L0379)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics (L0176)	Lecture	2	2
Reliability in Engineering Dynamics (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L0749)	Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of product development, materials and production Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> - <i>Autonomy</i> <ul style="list-style-type: none"> Students are able to develop their knowledge and skills by autonomous election of courses. 			
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1592: Applied Automation	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> -Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy
Literature	<p>John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005</p> <p>Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010</p> <p>K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wiley & Sons, Inc., 1992</p>

Course L0653: Ergonomics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Armin Bossemeyer
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0927: Elements of Integrated Production Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	not available
Literature	<p>Harris, R.; Harris, C.; Wilson, E.: Making Materials Flow, Lean Enterprise Institute, Cambridge, 2003.</p> <p>Ohno, T.: Das Toyota-Produktionssystem, Campus-Verlag, Frankfurt et al, 1993.</p> <p>Rother, M.: Die Kata des Weltmarktführers. Toyotas Erfolgsmethoden, Campus-Verlag, Frankfurt et al, 2009.</p> <p>Rother, M.; Shook, J.: Sehen lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen, Lean Management Institut, Aachen, 2006.</p> <p>Rother, M.; Harris, R.: Creating Continuous Flow, Lean Enterprise Institute, Brookline, 2001.</p> <p>Shingo, S.: A Revolution in Manufacturing. The SMED System, Productivity Press, 2006.</p> <p>Womack, J. P. et al: Die zweite Revolution in der Autoindustrie, Frankfurt/New York, Campus Verlag, 1992.</p>

Course L1512: Development Management for Mechatronics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Johannes Nicolas Gebhardt, Dr. Daniel Steffen
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Processes and methods of product development - from idea to market launch <ul style="list-style-type: none"> identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development <ul style="list-style-type: none"> Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	<ul style="list-style-type: none"> Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

Course L0310: Fatigue & Damage Tolerance	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Martin Flamm
Language	EN
Cycle	WiSe
Content	Design principles, fatigue strength, crack initiation and crack growth, damage calculation, counting methods, methods to improve fatigue strength, environmental influences
Literature	Jaap Schijve, Fatigue of Structures and Materials. Kluwer Academic Publisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

Course L2012: Industry 4.0 for engineers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	120 min
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2168: Innovation and Product Management	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christoph Fuchs
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L1258: Lightweight Design Practical Course	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	<p>Development of a sandwich structure made of fibre reinforced plastics</p> <ul style="list-style-type: none"> • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion“, Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation“, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0950: Mechanisms, Systems and Processes of Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	<p>Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies</p> <ul style="list-style-type: none"> • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	<ul style="list-style-type: none"> • E. Macherauch: Praktikum in Werkstoffkunde, Vieweg • G. E. Dieter: Mechanical Metallurgy, McGraw-Hill • R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg • R. Bürgel: Werkstoffe sicher beurteilen und richtig einsetzen, Vieweg

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0724: Microsystems Technology	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction (historical view, scientific and economic relevance, scaling laws) • Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) • Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) • Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) • Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) • Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) • Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) • Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) • Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics) • MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration) • Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship) • System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	<p>M. Madou: Fundamentals of Microfabrication, CRC Press, 2002</p> <p>N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009</p> <p>T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010</p> <p>G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0928: Productivity Management	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Principles of productivity management • Shop floor management and standardisation • Takt analysis and design of manual operations • Maintenance Principles • Total Productive Maintenance (TPM) • Optimisation of set-up operations • Analysis of interlinked production systems
Literature	<p>Bokranz, R.; Landau, K.: Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.</p> <p>Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.</p> <p>Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.</p> <p>Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985</p>

Course L0931: Productivity Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0664: Feedback Control in Medical Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	<p>Always viewed from the engineer's point of view, the lecture is structured as follows:</p> <ul style="list-style-type: none"> • Introduction to the topic • Fundamentals of physiological modelling • Introduction to Breathing and Ventilation • Physiology and Pathology in Cardiology • Introduction to the Regulation of Blood Glucose • kidney function and renal replacement therapy • Representation of the control technology on the concrete ventilator • Excursion to a medical technology company <p>Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.</p>
Literature	<ul style="list-style-type: none"> • Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. • Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. • Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Course L1130: Six Sigma	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Claus Emmelmann
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction and structuring • Basic terms of quality management • Measuring and inspection equipment • Tools of quality management: FMEA, QFD, FTA, etc. • Quality management methodology Six Sigma, DMAIC
Literature	<p>Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008</p> <p>Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996</p> <p>Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008</p>

Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	<p>Classical laminate theory</p> <p>Rules of mixture</p> <p>Failure mechanisms and criteria of composites</p> <p>Boundary value problems of isotropic and anisotropic shells</p> <p>Stability of composite structures</p> <p>Optimization of laminated composites</p> <p>Modelling composites in FEM</p> <p>Numerical multiscale analysis of textile composites</p> <p>Progressive failure analysis</p>
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, aktuelle Auflage. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, , aktuelle Auflage. • Reddy, J.N., „Mechanics of Composite Laminated Plates and Shells“, CRC Publishing, Boca Raton et al., current edition. • Jones, R.M., „Mechanics of Composite Materials“, Scripta Book Co., Washington, current edition. • Timoshenko, S.P., Gere, J.M., „Theory of elastic stability“, McGraw-Hill Book Company, Inc., New York, current edition. • Turvey, G.J., Marshall, I.H., „Buckling and postbuckling of composite plates“, Chapman and Hall, London, current edition. • Herakovich, C.T., „Mechanics of fibrous composites“, John Wiley and Sons, Inc., New York, current edition. • Mittelstedt, C., Becker, W., „Strukturmechanik ebener Lamine“, aktuelle Auflage.

Course L1820: System Simulation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	<p>Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica.</p> <ul style="list-style-type: none"> • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	<p>[1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7</p> <p>[2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014.</p> <p>[3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</p> <p>[4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</p> <p>[5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1821: System Simulation	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Basics with analysis, concept, proposal drawings and sketches Samples from practice of technical industrial design Product concept with new ideas and package ID proposal with structural concept and external product ergonomics Visualisation and presentation of the overall concept Realization as individual case studies
Literature	<p>Literatur über technisches Produktdesign</p> <p>Technisches Rendering und Präsentation</p> <p>Zeichnen und perspektivisches Entwerfen</p> <p>Literaturhinweise</p> <p>What is Product Design ?</p> <p>Laura Slack</p> <p>RotoVision Schweiz 2006</p> <p>Product Design Now</p> <p>Design and Scetches</p> <p>CollinsDesign and maomao publications Spanien 2006</p> <p>Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects,</p> <p>Watson, Gupta Publications,a division of Billboard Publications Inc., New York 1983</p> <p>Creative Techniques</p> <p>DRAWING</p> <p>Barons Educational Series</p> <p>ISBN-13: 978-0-7641-6182-7</p> <p>Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators</p> <p>Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985</p> <p>AIRWORLD</p> <p>Design und Architektur für die Flugreise</p> <p>Vitra Design Stiftung Weil am Rhein 2004</p>

	<p>Airline Design</p> <p>Perter Deslius Jacek Slaski te Neues 2005</p> <p>Technik und Sicherheit von Passagierflugzeugen</p> <p>Frank Littek</p> <p>Motorbuch Verlag 2003</p> <p>Jetliner Cabins</p> <p>Jennifer Coutts Clay</p> <p>Cs books England 2006</p> <p>BOEING Widebodies</p> <p>Michael Haenggi motorbooks international USA 2003</p> <p>form - Zeitschrift für Gestaltung, Verlag form GmbH,</p> <p>Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim</p> <p>(erscheint vierteljährlich, Verlag form GmbH)</p> <p>design report</p> <p>german magasin,</p> <p>(erscheint monatlich)</p> <p>md - möbel interior design, Konradin-Verlag</p> <p>Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen</p> <p>(erscheint monatlich)</p> <p>CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,</p> <p>Kitashinjuku, Shinjuku-ku, Tokio 160, Japan</p> <p>(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,</p> <p>Auto & Design,</p> <p>Corso Frabcia 161, 10139 Torino, Italia</p> <p>(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei</p> <p>Monate , erhältlich am HBF Hamburg</p> <p>AERO International,</p> <p>Magazin für Zivilluftfahrt</p> <p>(erscheint monatlich)</p> <p>Aircraft interior international</p> <p>Engl. magasin for Aircraft cabin interior</p> <p>(erscheint 2 monatlich)</p> <p>aerotec</p> <p>Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie</p>
--	---

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0379: Ceramics Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Rolf Janßen
Language	DE/EN
Cycle	WiSe
Content	<p>Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metallurgical techniques and sintering (solid state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed. Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.</p> <p>Content:</p> <ol style="list-style-type: none"> 1. Introduction 2. Raw materials 3. Powder fabrication 4. Powder processing 5. Shape-forming processes 6. Densification, sintering 7. Glass and Cement technology 8. Ceramic-metal joining techniques <p>Inhalt:</p>
Literature	<p>W.D. Kingery, „Introduction to Ceramics“, John Wiley & Sons, New York, 1975</p> <p>ASM Engineering Materials Handbook Vol.4 „Ceramics and Glasses“, 1991</p> <p>D.W. Richerson, „Modern Ceramic Engineering“, Marcel Dekker, New York, 1992</p> <p>Skript zur Vorlesung</p>

Course L0949: Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	<p>Application and analysis of basic mechanical as well as non-destructive testing of materials</p> <ul style="list-style-type: none"> • Determination elastic constants • Tensile test • Fatigue test (testing with constant stress, strain, or plastic strain amplitude, low and high cycle fatigue, mean stress effect) • Crack growth upon static loading (stress intensity factor, fracture toughness) • Creep test • Hardness test • Charpy impact test • Non destructive testing
Literature	<p>E. Macherauch: Praktikum in Werkstoffkunde, Vieweg</p> <p>G. E. Dieter: Mechanical Metallurgy, McGraw-Hill</p>

Course L0176: Reliability in Engineering Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min.
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	<p>Method for calculation and testing of reliability of dynamic machine systems</p> <ul style="list-style-type: none"> • Modeling • System identification • Simulation • Processing of measurement data • Damage accumulation • Test planning and execution
Literature	<p>Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4</p> <p>Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737</p> <p>Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.</p> <p>VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412</p>

Course L1303: Reliability in Engineering Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0749: Reliability of Aircraft Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wiecek
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Functions of reliability and safety (regulations, certification requirements) • Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment) • Reliability analysis of electrical and mechanical systems
Literature	<ul style="list-style-type: none"> • CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1226: Mechanical Properties			
Courses			
Title	Typ	Hrs/wk	CP
Mechanical Behaviour of Brittle Materials (L1661)	Lecture	2	3
Dislocation Theory of Plasticity (L1662)	Lecture	2	3
Module Responsible	Dr. Erica Lilleodden		
Admission Requirements	None		
Recommended Previous Knowledge	Basics in Materials Science I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p>Students can explain basic principles of crystallography, statics (free body diagrams, tractions) and thermodynamics (energy minimization, energy barriers, entropy)</p> <p>Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations</p> <p>Students can provide appropriate feedback and handle feedback on their own performance constructively.</p> <p>Students are able to</p> <ul style="list-style-type: none"> - assess their own strengths and weaknesses - assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers. - work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed 		
<i>Knowledge</i>			
<i>Skills</i>			
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	<p>Materials Science: Core Qualification: Compulsory</p> <p>Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p>		

Course L1661: Mechanical Behaviour of Brittle Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider
Language	DE/EN
Cycle	SoSe
Content	<p>Theoretical Strength Of a perfect crystalline material, theoretical critical shear stress</p> <p>Real strength of brittle materials Energy release reate, stress intensity factor, fracture criterion</p> <p>Scattering of strength of brittle materials Defect distribution, strength distribution, Weibull distribution</p> <p>Heterogeneous materials I Internal stresses, micro cracks, weight function,</p> <p>Heterogeneous materials II Toughening mechanisms: crack bridging, fibres</p> <p>Heterogeneous materials III Toughening mechanisms. Process zone</p> <p>Testing methods to determine the fracture toughness of brittle materials</p> <p>R-curve, stable/unstable crack growth, fractography</p> <p>Thermal shock</p> <p>Subcritical crack growth) v-K-curve, life time prediction</p> <p>Kriechen</p> <p>Mechanical properties of biological materials</p> <p>Examples of use for a mechanically reliable design of ceramic components</p>
Literature	<p>D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elsevier</p> <p>D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998</p> <p>B.R. Lawn, Fracture of Brittle Solids", Cambridge University Press, 1993</p> <p>D. Munz, T. Fett, Ceramics, Springer, 2001</p> <p>D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992</p>

Course L1662: Dislocation Theory of Plasticity	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Erica Lilleodden
Language	DE/EN
Cycle	SoSe
Content	<p>This class will cover the principles of dislocation theory from a physical metallurgy perspective, providing a fundamental understanding of the relations between the strength and of crystalline solids and distributions of defects.</p> <p>We will review the concept of dislocations, defining terminology used, and providing an overview of important concepts (e.g. linear elasticity, stress-strain relations, and stress transformations) for theory development. We will develop the theory of dislocation plasticity through derived stress-strain fields, associated self-energies, and the induced forces on dislocations due to internal and externally applied stresses. Dislocation structure will be discussed, including core models, stacking faults, and dislocation arrays (including grain boundary descriptions). Mechanisms of dislocation multiplication and strengthening will be covered along with general principles of creep and strain rate sensitivity. Final topics will include non-FCC dislocations, emphasizing the differences in structure and corresponding implications on dislocation mobility and macroscopic mechanical behavior; and dislocations in finite volumes.</p>
Literature	<p>Vorlesungsskript</p> <p>Aktuelle Publikationen</p> <p>Bücher:</p> <p>Introduction to Dislocations, by D. Hull and D.J. Bacon</p> <p>Theory of Dislocations, by J.P. Hirth and J. Lothe</p> <p>Physical Metallurgy, by Peter Hassen</p>

Module M0840: Optimal and Robust Control			
Courses			
Title	Typ	Hrs/wk	CP
Optimal and Robust Control (L0658)	Lecture	2	3
Optimal and Robust Control (L0659)	Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner		
Admission Requirements	None		
Recommended Previous Knowledge	<ul style="list-style-type: none"> Classical control (frequency response, root locus) State space methods Linear algebra, singular value decomposition 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students can explain the significance of the matrix Riccati equation for the solution of LQ problems. They can explain the duality between optimal state feedback and optimal state estimation. They can explain how the H2 and H-infinity norms are used to represent stability and performance constraints. They can explain how an LQG design problem can be formulated as special case of an H2 design problem. They can explain how model uncertainty can be represented in a way that lends itself to robust controller design They can explain how - based on the small gain theorem - a robust controller can guarantee stability and performance for an uncertain plant. They understand how analysis and synthesis conditions on feedback loops can be represented as linear matrix inequalities. <i>Skills</i> <ul style="list-style-type: none"> Students are capable of designing and tuning LQG controllers for multivariable plant models. They are capable of representing a H2 or H-infinity design problem in the form of a generalized plant, and of using standard software tools for solving it. They are capable of translating time and frequency domain specifications for control loops into constraints on closed-loop sensitivity functions, and of carrying out a mixed-sensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain system, and of designing a mixed-objective robust controller. They are capable of formulating analysis and synthesis conditions as linear matrix inequalities (LMI), and of using standard LMI-solvers for solving them. They can carry out all of the above using standard software tools (Matlab robust control toolbox). Personal Competence <i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions. <i>Autonomy</i> Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Oral exam		
Examination duration and scale	30 min		
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0658: Optimal and Robust Control	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Optimal regulator problem with finite time horizon, Riccati differential equation • Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system • Kalman's identity, phase margin of LQR controllers, spectral factorization • Optimal state estimation, Kalman filter, LQG control • Generalized plant, review of LQG control • Signal and system norms, computing H_2 and H_∞ norms • Singular value plots, input and output directions • Mixed sensitivity design, H_∞ loop shaping, choice of weighting filters • Case study: design example flight control • Linear matrix inequalities, design specifications as LMI constraints (H_2, H_∞ and pole region) • Controller synthesis by solving LMI problems, multi-objective design • Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty
Literature	<ul style="list-style-type: none"> • Werner, H., Lecture Notes: "Optimale und Robuste Regelung" • Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 • Skogestad, S. and I. Postlewaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 • Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 • Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998

Course L0659: Optimal and Robust Control	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1344: Processing of fibre-polymer-composites			
Courses			
Title	Typ	Hrs/wk	CP
Processing of fibre-polymer-composites (L1895)	Lecture	2	3
From Molecule to Composites Part (L1516)	Project/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler		
Admission Requirements	None		
Recommended Previous Knowledge	Knowledge in the basics of chemistry / physics / materials science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p><i>Knowledge</i> Students are able to give a summary of the technical details of the manufacturing processes composites and illustrate respective relationships. They are capable of describing and communicating relevant problems and questions using appropriate technical language. They can explain the typical process of solving practical problems and present related results.</p> <p><i>Skills</i> Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents (fiber / matrix) and define the necessary testing and analysis.</p> <p>They can explain the complex structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection).</p> <p>Personal Competence</p> <p><i>Social Competence</i> Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the context of civil engineering. They are able to effectively present and explain their results alone or in groups in front of a qualified audience. Students have the ability to develop alternative approaches to an engineering problem independently or in groups and discuss advantages as well as drawbacks.</p> <p><i>Autonomy</i> Students are capable of independently solving mechanical engineering problems using provided literature. They are able to fill gaps in as well as extent their knowledge using the literature and other sources provided by the supervisor. Furthermore, they can meaningfully extend given problems and pragmatically solve them by means of corresponding solutions and concepts.</p>		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Course L1895: Processing of fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	Manufacturing of Composites: Hand Lay-Up; Pre-Preg; GMT, BMC; SMC, RIM; Pultrusion; Filament Winding
Literature	Åström: Manufacturing of Polymer Composites, Chapman and Hall

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1516: From Molecule to Composites Part	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	<p>Students get the task in the form of a customer request for the development and production of a MTB handlebar made of fiber composites. In the task technical and normative requirements (standards) are given, all other required information come from the lectures and tutorials, and the respective documents (electronically and in conversation).</p> <p>The procedure is to specify in a milestone schedule and allows students to plan tasks and to work continuously. At project end, each group has a made handlebar with approved quality.</p> <p>In each project meeting the design (discussion of the requirements and risks) are discussed. The calculations are analyzed, evaluated and established manufacturing methods are selected. Materials are selected bar will be produced. The quality and the mechanical properties are checked. At the end of the final report created (compilation of the results for the "customers").</p> <p>After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.</p>
Literature	Customer Request ("Handout")

Module M1343: Fibre-polymer-composites			
Courses			
Title	Typ	Hrs/wk	CP
Structure and properties of fibre-polymer-composites (L1894)	Lecture	2	3
Design with fibre-polymer-composites (L1893)	Lecture	2	3
Module Responsible	Prof. Bodo Fiedler		
Admission Requirements	None		
Recommended Previous Knowledge	Basics: chemistry / physics / materials science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis.</p> <p>They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection).</p> <p>Students are capable of</p> <ul style="list-style-type: none"> • using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. • approximate sizing using the network theory of the structural elements implement and evaluate. • selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance. <p>Students can</p> <ul style="list-style-type: none"> • arrive at funded work results in heterogenius groups and document them. • provide appropriate feedback and handle feedback on their own performance constructively. <p>Students are able to</p> <ul style="list-style-type: none"> - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 min		
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1894: Structure and properties of fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - Microstructure and properties of the matrix and reinforcing materials and their interaction - Development of composite materials - Mechanical and physical properties - Mechanics of Composite Materials - Laminate theory - Test methods - Non destructive testing - Failure mechanisms - Theoretical models for the prediction of properties - Application
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press Mallick: Fibre-Reinforced Composites, Marcel Dekker, New York

Course L1893: Design with fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	Designing with Composites: Laminate Theory; Failure Criteria; Design of Pipes and Shafts; Sandwich Structures; Notches; Joining Techniques; Compression Loading; Examples
Literature	Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag

Module M1174: Automation Technology and Systems								
Courses								
Title		Typ	Hrs/wk	CP				
Automation Technology and Systems (L2329)		Lecture	4	4				
Automation Technology and Systems (L2331)		Project-/problem-based Learning	1	1				
Automation Technology and Systems (L2330)		Recitation Section (small)	1	1				
Module Responsible	Prof. Thorsten Schüppstuhl							
Admission Requirements	None							
Recommended Previous Knowledge	without major course assessment							
Educational Objectives	After taking part successfully, students have reached the following learning results							
Professional Competence	<div>Knowledge</div> <div>Students<ul style="list-style-type: none">know the characteristic components of an automation systems and have good understanding of their interactionknow methods for a systematical analysis of automation tasks and are able to use themhave special competences in industrial robot based automation systems</div> <div>Skills</div> <div>Students are able to...<ul style="list-style-type: none">analyze complex Automation tasksdevelop application based concepts and solutionsdesign subsystems and integrate into one systeminvestigate and evaluate safety of machinerycreate simple programs for robots and programmable logic controllersdesign of circuit for pneumatic applications</div> <div>Personal Competence</div> <div>Social Competence</div> <div>Students are able to ...<ul style="list-style-type: none">find solutions for automation and handling tasks in groupsdevelop solutions in a production environment with qualified personnel at technical level and represent decisions.</div> <div>Autonomy</div> <div>Students are able to ...<ul style="list-style-type: none">analyze automation tasks independentlygenerate programs for robots and programmable logic devices autonomouslydevelop solutions for practice oriented tasks of automation independentlydesign safety concepts for automation applicationsassess consequences of their professional actions and responsibilities</div>							
Workload in Hours					Independent Study Time 96, Study Time in Lecture 84			
Credit points					6			
Course achievement					None			
Examination					Written exam			
Examination duration and scale					120 min			
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory							

Course L2329: Automation Technology and Systems	
Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2331: Automation Technology and Systems	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2330: Automation Technology and Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0563: Robotics			
Courses			
Title	Typ	Hrs/wk	CP
Robotics: Modelling and Control (L0168)	Integrated Lecture	4	4
Robotics: Modelling and Control (L1305)	Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of electrical engineering Broad knowledge of mechanics Fundamentals of control theory		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to describe fundamental properties of robots and solution approaches for multiple problems in robotics. Students are able to derive and solve equations of motion for various manipulators. Students can generate trajectories in various coordinate systems. Students can design linear and partially nonlinear controllers for robotic manipulators. Students are able to work goal-oriented in small mixed groups. Students are able to recognize and improve knowledge deficits independently. With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory		

Course L0168: Robotics: Modelling and Control	
Typ	Integrated Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Dr. Martin Gomse
Language	EN
Cycle	WiSe
Content	Fundamental kinematics of rigid body systems Newton-Euler equations for manipulators Trajectory generation Linear and nonlinear control of robots
Literature	Craig, John J.: Introduction to Robotics Mechanics and Control, Third Edition, Prentice Hall. ISBN 0201-54361-3 Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M. : Robot Modeling and Control. WILEY. ISBN 0-471-64990-2

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1305: Robotics: Modelling and Control	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Martin Gomse
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0771: Flight Physics				
Courses				
Title		Typ	Hrs/wk	CP
Aerodynamics and Flight Mechanics I (L0727)		Lecture	3	3
Flight Mechanics II (L0730)		Lecture	2	2
Flight Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none">• Mathematics• Mechanics• Thermodynamics• Aviation			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes (WS) + 90 Minutes (SS)			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0727: Aerodynamics and Flight Mechanics I	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich, Mike Montel
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none">• Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows)• Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)
Literature	<ul style="list-style-type: none">• Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II• Etkin, B.: Dynamics of Atmospheric Flight• Sachs/Hafer: Flugmechanik• Brockhaus: Flugregelung• J.D. Anderson: Introduction to flight

Course L0730: Flight Mechanics II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • stationary asymmetric flight • dynamics of lateral movement • methods of flight simulation • experimental methods of flight mechanics • model validation using system identification • wind tunnel techniques
Literature	<ul style="list-style-type: none"> • Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II • Etkin, B.: Dynamics of Atmospheric Flight • Sachs/Hafer: Flugmechanik • Brockhaus: Flugregelung • J.D. Anderson: Introduction to flight

Course L0731: Flight Mechanics II	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0815: Product Planning				
Courses				
Title			Typ	Hrs/wk CP
Product Planning (L0851)			Lecture	3 3
Product Planning Seminar (L0853)			Project-/problem-based Learning	2 3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Good basic-knowledge of Business Administration			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students will gain insights into:			
	<ul style="list-style-type: none"> Product Planning <ul style="list-style-type: none"> Process Methods Design thinking <ul style="list-style-type: none"> Process Methods User integration 			
<i>Skills</i>	Students will gain deep insights into:			
	<ul style="list-style-type: none"> Product Planning <ul style="list-style-type: none"> Process-related aspects Organisational-related aspects Human-Ressource related aspects Working-tools, methods and instruments 			
Personal Competence				
<i>Social Competence</i>	<ul style="list-style-type: none"> Interact within a team Raise awareness for globabl issues 			
<i>Autonomy</i>	<ul style="list-style-type: none"> Gain access to knowledge sources Interpret complex cases Develop presentation skills 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	20 %	Subject	theoretical and practical work
Examination	Written exam			
Examination duration and scale	90 minutes			
Assignment for the Following Curricula	Global Innovation Management: Core Qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0851: Product Planning	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	<p>Product Planning Process</p> <p>This integrated lecture is designed to understand major issues, activities and tools in the context of systematic product planning, a key activity for managing the front-end of innovation, i.e.:</p> <ul style="list-style-type: none"> • Systematic scanning of markets for innovation opportunities • Understanding strengths/weakness and specific core competences of a firm as platforms for innovation • Exploring relevant sources for innovation (customers, suppliers, Lead Users, etc.) • Developing ideas for radical innovation, relying on the creativeness of employees, using techniques to stimulate creativity and creating a stimulating environment • Transferring ideas for innovation into feasible concepts which have a high market attractively <p>Voluntary presentations in the third hour (articles / case studies)</p> <ul style="list-style-type: none"> - Guest lectures by researchers - Lecture on Sustainability with frequent reference to current research - Permanent reference to current research <p>Examination:</p> <p>In addition to the written exam at the end of the module, students have to attend the PBL-exercises and prepare presentations in groups in order to pass the module. Additionally, students have the opportunity to present research papers on a voluntary base. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.</p>
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010

Course L0853: Product Planning Seminar	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Seminar is integrative part of the Module Product Planning (for content see lecture) and can not be chosen independantly.
Literature	See lecture information "Product Planning".

Module M0830: Environmental Protection and Management				
Courses				
Title		Typ	Hrs/wk	CP
Integrated Pollution Control (L0502)		Lecture	2	2
Health, Safety and Environmental Management (L0387)		Lecture	2	3
Health, Safety and Environmental Management (L0388)		Recitation Section (small)	1	1
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none">• Good knowledge in Technologies for Environmental Protection (end-of-pipe, integrated solutions)• Good knowledge of the relevant Environmental Legislation• Basic knowledge of instruments for Environmental Assessment			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>				
<i>Skills</i>				
<i>Personal Competence</i>				
<i>Social Competence</i>	The students can work together in international groups.			
<i>Autonomy</i>	Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. They can acquire appropriate knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory Environmental Engineering: Core Qualification: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Energy: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Compulsory			

Course L0502: Integrated Pollution Control	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<p>The lecture focusses on:</p> <ul style="list-style-type: none"> • The Regulatory Framework • Pollution & Impacts, Characteristics of Pollutants • Approaches of Integrated Pollution Control • Sevilla Process, Best Available Technologies & BREF Documents • Case Studies: paper industry, cement industry, automotive industry • Field Trip
Literature	<p>Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0</p> <p>Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3</p>

Course L0387: Health, Safety and Environmental Management	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Objectives of and benefit from HSE management • From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives • Fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements Environmental performance evaluation Risk management: hazard, risk and safety Health and safety at the workplace • Crisis management
Literature	<p>C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315)</p> <p>Exercises can be downloaded from StudIP</p>

Course L0388: Health, Safety and Environmental Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0867: Production Planning & Control and Digital Enterprise			
Courses			
Title	Typ	Hrs/wk	CP
The Digital Enterprise (L0932)	Lecture	2	2
Production Planning and Control (L0929)	Lecture	2	2
Production Planning and Control (L0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödging		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of Production and Quality Management		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<i>Knowledge</i> Students can explain the contents of the module in detail and take a critical position to them. <i>Skills</i> Students are capable of choosing and applying models and methods from the module to industrial problems. Personal Competence <i>Social Competence</i> Students can develop joint solutions in mixed teams and present them to others. <i>Autonomy</i> -		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 Minuten		
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L0932: The Digital Enterprise	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	<p>Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered.</p> <p>Content:</p> <ul style="list-style-type: none">• Business Process Management and Data Modelling, Simulation• Knowledge and Competence Management• Process Management (PPC, Workflow Management)• Computer Aided Planning (CAP) and NC-Programming• Virtual Reality (VR) and Augmented Reality (AR)• Computer Aided Quality Management (CAQ)• Industry 4.0
Literature	<p>Scheer, A.-W.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002</p> <p>Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag, Berlin 3. Auflage 2006</p> <p>Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004</p> <p>Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007</p> <p>Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006</p>

Course L0929: Production Planning and Control	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Models of Production and Inventory Management • Production Programme Planning and Lot Sizing • Order and Capacity Scheduling • Selected Strategies of PPC • Manufacturing Control • Production Controlling • Supply Chain Management
Literature	<ul style="list-style-type: none"> • Vorlesungsskript • Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 • Nyhuis, P.; Wiendahl, H.-P.: Logistische Kennlinien, Springer 2002

Course L0930: Production Planning and Control	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0933: Exercise: The Digital Enterprise	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	<p>Siehe korrespondierende Vorlesung</p> <p>See interlocking course</p>

Module M0962: Sustainability and Risk Management				
Courses				
Title		Typ	Hrs/wk	CP
Safety, Reliability and Risk Assessment (L1145)		Seminar	2	3
Environment and Sustainability (L0319)		Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	Students are able to describe single techniques and to give an overview for the field of safety and risk assessment as well as environmental and sustainable engineering, in detail: <ul style="list-style-type: none">basics in safety and reliability of technical facilitiessafety and reliability analysis methodsrisk assessmentProduction and usage of bio-charenergy production and supplysustainable product design Students are able apply interdisciplinary system-oriented methods for risk assessment and sustainability reporting. They can evaluate the effort and costs for processes and select economically feasible treatment concepts.			
Knowledge				
Skills				
Personal Competence				
Social Competence	Students can gain knowledge of the subject area from given sources and transform it to new questions. Furthermore, they can define targets for new application or research-oriented duties in for risk management and sustainability concepts accordance with the potential social, economic and cultural impact.			
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	Elaboration and presentation (45 minutes in groups)			
Assignment for the Following Curricula	Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Water and Environmental Engineering: Core Qualification: Compulsory			

Course L1145: Safety, Reliability and Risk Assessment	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski
Language	DE
Cycle	WiSe
Content	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated: <ul style="list-style-type: none">basics in safety and reliability of technical facilitiessafety and reliability analysis methodsrisk assessmentpractical examples and excursionsdiscussions and presentations
Literature	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/sicherheit_und_zuverlaessigkeit.pdf

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0319: Environment and Sustainability	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	<p>This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list show examples.</p> <p>Production and Usage of Bio-char Engergy production with algae Environmental product design Clean Development mechanism (CDM) Democracy and Energy New Concepts for a sustainable Energy Supply</p> <p>Recycling of Wind Turbines Alternative Mobility</p> <p>Disposal of Nuclear Wastes Waste2Energy Offshore Wind energy</p>
Literature	Wird in der Veranstaltung bekannt gegeben.

Module M1155: Aircraft Cabin Systems				
Courses				
Title	Typ		Hrs/wk	CP
Aircraft Cabin Systems (L1545)	Lecture		3	4
Aircraft Cabin Systems (L1546)	Recitation Section (large)		1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • describe cabin operations, equipment in the cabin and cabin Systems • explain the functional and non-functional requirements for cabin Systems • elucidate the necessity of cabin operating systems and emergency Systems • assess the challenges human factors integration in a cabin environment Students are able to: <ul style="list-style-type: none"> • design a cabin layout for a given business model of an Airline • design cabin systems for safe operations • design emergency systems for safe man-machine interaction • solve comfort needs and entertainment requirements in the cabin Students are able to: <ul style="list-style-type: none"> • understand existing system solutions and discuss their ideas with experts Students are able to: <ul style="list-style-type: none"> • Reflect the contents of lectures and expert presentations self-dependent 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes			
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L1545: Aircraft Cabin Systems	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge about aircraft cabin systems and cabin operations. A basic understanding of technological and systems engineering effort to maintain an artificial but comfortable and safe travel and working environment at cruising altitude is to be achieved.</p> <p>The course provides a comprehensive overview of current technology and cabin systems in modern passenger aircraft. The Fulfillment of requirements for the cabin as the central system of work are covered on the basis of the topics comfort, ergonomics, human factors, operational processes, maintenance and energy supply:</p> <ul style="list-style-type: none"> • Materials used in the cabin • Ergonomics and human factors • Cabin interior and non-electrical systems • Cabin electrical systems and lights • Cabin electronics, communication-, information- and IFE-systems • Cabin and passenger process chains • RFID Aircraft Parts Marking • Energy sources and energy conversion
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, C.-C., Wolf, K., Horst, P. (Hrsg.): Handbuch der Luftfahrzeugtechnik. Carl Hanser Verlag, 2014 - Moir, I., Seabridge, A.: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Wiley 2008 - Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGraw-Hill, 2003 - Kompendium der Flugmedizin. Verbesserte und ergänzte Neuauflage, Nachdruck April 2006. Fürstentfeldbruck, 2006 - Campbell, F.C.: Manufacturing Technology for Aerospace Structural Materials. Elsevier Ltd., 2006

Course L1546: Aircraft Cabin Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1183: Laser Systems and Methods of Manufacturing Design and Analysis				
Courses				
Title		Typ	Hrs/wk	CP
Laser Systems and Process Technologies (L1612)		Lecture	2	3
Methods for Analysing Production Processes (L0876)		Lecture	2	3
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Course L1612: Laser Systems and Process Technologies	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> Fundamentals of laser technology Laser beam sources: CO₂-, Nd:YAG-, Fiber- and Diodelasers Laser system technology: beam forming, beam guidance systems, beam motion and beam control Laser-based manufacturing technologies: generation, marking, cutting, joining, surface treatment Quality assurance and economical aspects of laser material processing Markets and Applications of laser technology Student group exercises
Literature	<ul style="list-style-type: none"> Hügel, H. , T. Graf: Laser in der Fertigung : Strahlquellen, Systeme, Fertigungsverfahren, 3. Aufl., Vieweg + Teubner Wiesbaden 2014. Eichler, J., Eichler, H. J.: Laser: Bauformen, Strahlführung, Anwendungen, 7. Aufl., Springer-Verlag Berlin Heidelberg 2010. Steen W. M.; Mazumder J.: Laser material processing, 4th Edition, Springer-Verlag London 2010. J.C. Ion: Laser processing of engineering materials: principles, procedure and industrial applications, Elsevier Butterworth-Heinemann 2005. Gebhardt, A.: Understanding additive manufacturing, München [u.a.] Hanser 2011

Course L0876: Methods for Analysing Production Processes	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Modelling and simulation of machining and forming processes • Numerical simulation of forces, temperatures, deformation in machining • Analysis of vibration problems in machining (chatter, modal analysis,...) • Knowledge based process planning • Design of experiments • Machinability of nonmetallic materials • Analysis of interaction between machining process and machine tool systems with regard to process stability and quality • Simulation of machining processes by virtual reality methods
Literature	<p>Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004)</p> <p>Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006)</p> <p>Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001)</p> <p>Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)</p>

Module M1342: Polymers			
Courses			
Title	Typ	Hrs/wk	CP
Structure and Properties of Polymers (L0389)	Lecture	2	3
Processing and design with polymers (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich		
Admission Requirements	None		
Recommended Previous Knowledge	Basics: chemistry / physics / material science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	Students can use the knowledge of plastics and define the necessary testing and analysis. They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environmental protection).		
<i>Skills</i>	Students are capable of - using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. - selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.		
Personal Competence <i>Social Competence</i>	Students can - arrive at funded work results in heterogenius groups and document them. - provide appropriate feedback and handle feedback on their own performance constructively.		
<i>Autonomy</i>	Students are able to - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 min		
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		

Course L0389: Structure and Properties of Polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> - Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weight distribution - Morphology amorph, crystalline, blends - Properties Elasticity, plasticity, viscoelasticity - Thermal properties - Electrical properties - Theoretical modelling - Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing and design with polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich
Language	DE/EN
Cycle	WiSe
Content	<p>Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining</p> <p>Designing with Polymers: Materials Selection; Structural Design; Dimensioning</p>
Literature	<p>Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag</p> <p>Crawford: Plastics engineering, Pergamon Press</p> <p>Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag</p> <p>Konstruieren mit Kunststoffen, Gunter Erhard, Hanser Verlag</p>

Module M1170: Phenomena and Methods in Materials Science			
Courses			
Title	Typ	Hrs/wk	CP
Experimental Methods for the Characterization of Materials (L1580)	Lecture	2	3
Phase equilibria and transformations (L1579)	Lecture	2	3
Module Responsible	Prof. Jörg Weißmüller		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Werkstoffwissenschaft I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.		
<i>Skills</i>	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.		
Personal Competence			
<i>Social Competence</i>	The students are able to present solutions to specialists and to develop ideas further.		
<i>Autonomy</i>	The students are able to ... <ul style="list-style-type: none"> • assess their own strengths and weaknesses. • gather new necessary expertise by their own. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		

Course L1580: Experimental Methods for the Characterization of Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Jürgen Markmann, Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) • Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) • Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Course L1579: Phase equilibria and transformations	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	Fundamentals of statistical physics, formal structure of phenomenological thermodynamics, simple atomistic models and free-energy functions of solid solutions and compounds. Corrections due to nonlocal interaction (elasticity, gradient terms). Phase equilibria and alloy phase diagrams as consequence thereof. Simple atomistic considerations for interaction energies in metallic solid solutions. Diffusion in real systems. Kinetics of phase transformations for real-life boundary conditions. Partitioning, stability and morphology at solidification fronts. Order of phase transformations; glass transition. Phase transitions in nano- and microscale systems.
Literature	<p>D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage</p> <p>Peter Haasen, „Physikalische Metallkunde“ , Springer 1994</p> <p>Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage.</p> <p>Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996</p> <p>H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.</p>

Module M0812: Aircraft Design I (Civil Aircraft Design)				
Courses				
Title	Typ		Hrs/wk	CP
Aircraft Design I (Design of Transport Aircraft) (L0820)	Lecture		3	3
Aircraft Design I (Design of Transport Aircraft) (L0834)	Recitation Section (large)		2	3
Module Responsible	Prof. Volker Gollnick			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> • Bachelor Mech. Eng. • Bachelor Traffic Systems • Vordiplom Mech. Eng. • Module Air Transport Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i></p> <ol style="list-style-type: none"> 1. Principle understanding of integrated and civil aircraft design 2. Understanding of the interactions and contributions of the various disciplines 3. Impact of the relevant design parameter on the civil aircraft design 4. Introduction of the principle design methods <p><i>Skills</i></p> <p>Understanding and application of design and calculation methods</p> <p>Understanding of interdisciplinary and integrative interdependencies</p> <p>Personal Competence</p> <p><i>Social Competence</i></p> <p>Working in interdisciplinary teams</p> <p>Communication</p> <p><i>Autonomy</i></p> <p>Organization of workflows and -strategies</p>			
<i>Knowledge</i>				
<i>Skills</i>				
Personal Competence				
<i>Social Competence</i>				
<i>Autonomy</i>				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	No	10 %	Attestation	Durchführung einer Konzeptauslegung für ein Verkehrsflugzeug
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0820: Aircraft Design I (Design of Transport Aircraft)	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Volker Gollnick, Jens Thöben
Language	DE
Cycle	WiSe
Content	<p>Introduction into the aircraft design process</p> <ol style="list-style-type: none"> 1. Introduction/process of aircraft design/various aircraft configurations 2. Requirements and design objectives, main design parameter (u.a. payload-range-diagramme) 3. Statistical methods in overall aircraft design/data base methods 4. Cabin design (fuselage sizing, cabin interior, loading systems) 5. Principles of aerodynamic aircraft design (polar, geometry, 2D/3D aerodynamics) 6. Wing Design 7. Tail wings and landing gear 8. Principles of engine design and integration 9. Flight performance in cruise 10. Take off and landing field length 11. Loads and V-n-diagramme 12. Operating cost calculation
Literature	<p>J. Roskam: "Airplane Design"</p> <p>D.P. Raymer: "Aircraft Design - A Conceptual Approach"</p> <p>J.P. Fielding: "Introduction to Aircraft Design"</p> <p>Jenkinson, Simpkon, Rhods: "Civil Jet Aircraft Design"</p>

Course L0834: Aircraft Design I (Design of Transport Aircraft)	
Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Volker Gollnick, Jens Thöben
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)			
Courses			
Title	Typ	Hrs/wk	CP
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	See selected module according to FSPO		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>			
<i>Skills</i>			
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>			
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Specialization Production

Graduates of the discipline production have in-depth knowledge of various production and manufacturing processes. They are qualified to evaluate those in the context of geometry creation, error control, cost effectiveness and humanization of work and are able to consider the interfaces of technology, organization and human, holistically.

Module M0763: Aircraft Energy Systems (FS1)

Courses

Title	Typ	Hrs/wk	CP
Aircraft Systems I (L0735)	Lecture	3	4
Aircraft Systems I (L0739)	Recitation Section (large)	2	2

Module Responsible	Prof. Frank Thielecke
---------------------------	-----------------------

Admission Requirements	None
-------------------------------	------

Recommended Previous Knowledge	<p>Basic knowledge in:</p> <ul style="list-style-type: none"> Mathematics Mechanics Thermodynamics Electrical Engineering Hydraulics Control Systems
---------------------------------------	--

Educational Objectives	After taking part successfully, students have reached the following learning results
-------------------------------	--

Professional Competence <i>Knowledge</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Describe essential components and design points of hydraulic, electrical and high-lift systems Give an overview of the functionality of air conditioning systems Explain the need for high-lift systems such as its functionality and effects Assess the challenge during the design of supply systems of an aircraft
<i>Skills</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Design hydraulic and electric supply systems of aircrafts Design high-lift systems of aircrafts Analyze the thermodynamic behaviour of air conditioning systems
Personal Competence <i>Social Competence</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Perform system design in groups and present and discuss results
<i>Autonomy</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Reflect the contents of lectures autonomously

Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
--------------------------	--

Credit points	6
----------------------	---

Course achievement	None
---------------------------	------

Examination	Written exam
--------------------	--------------

Examination duration and scale	165 Minutes
---------------------------------------	-------------

Assignment for the Following Curricula	<p>Energy Systems: Specialisation Energy Systems: Elective Compulsory</p> <p>Aircraft Systems Engineering: Core Qualification: Compulsory</p> <p>International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory</p>
---	---

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0735: Aircraft Systems I	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> Hydraulic Energy Systems (Fluids; pressure loss in valves and pipes; components of hydraulic systems like pumps, valves, etc.; pressure/flow characteristics; actuators; tanks; power and heat balances; emergency power) Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis) High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices) Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)
Literature	<ul style="list-style-type: none"> Moir, Seabridge: Aircraft Systems Green: Aircraft Hydraulic Systems Torenbek: Synthesis of Subsonic Airplane Design SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes

Course L0739: Aircraft Systems I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0867: Production Planning & Control and Digital Enterprise			
Courses			
Title	Typ	Hrs/wk	CP
The Digital Enterprise (L0932)	Lecture	2	2
Production Planning and Control (L0929)	Lecture	2	2
Production Planning and Control (L0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödging		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of Production and Quality Management		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	Students can explain the contents of the module in detail and take a critical position to them. Students are capable of choosing and applying models and methods from the module to industrial problems. Students can develop joint solutions in mixed teams and present them to others. -		
Knowledge			
Skills			
Personal Competence			
Social Competence	Students can develop joint solutions in mixed teams and present them to others.		
Autonomy	-		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 Minuten		
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory		

Course L0932: The Digital Enterprise	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	<p>Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered.</p> <p>Content:</p> <ul style="list-style-type: none">• Business Process Management and Data Modelling, Simulation• Knowledge and Competence Management• Process Management (PPC, Workflow Management)• Computer Aided Planning (CAP) and NC-Programming• Virtual Reality (VR) and Augmented Reality (AR)• Computer Aided Quality Management (CAQ)• Industry 4.0
Literature	<p>Scheer, A.-W.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002</p> <p>Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006</p> <p>Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004</p> <p>Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007</p> <p>Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006</p>

Course L0929: Production Planning and Control	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Models of Production and Inventory Management • Production Programme Planning and Lot Sizing • Order and Capacity Scheduling • Selected Strategies of PPC • Manufacturing Control • Production Controlling • Supply Chain Management
Literature	<ul style="list-style-type: none"> • Vorlesungsskript • Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 • Nyhuis, P.; Wiendahl, H.-P.: Logistische Kennlinien, Springer 2002

Course L0930: Production Planning and Control	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0933: Exercise: The Digital Enterprise	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	<p>Siehe korrespondierende Vorlesung</p> <p>See interlocking course</p>

Module M1183: Laser systems and methods of manufacturing design and analysis				
Courses				
Title		Typ	Hrs/wk	CP
Laser Systems and Process Technologies (L1612)		Lecture	2	3
Methods for Analysing Production Processes (L0876)		Lecture	2	3
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory			

Course L1612: Laser Systems and Process Technologies	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> Fundamentals of laser technology Laser beam sources: CO₂-, Nd:YAG-, Fiber- and Diodelasers Laser system technology: beam forming, beam guidance systems, beam motion and beam control Laser-based manufacturing technologies: generation, marking, cutting, joining, surface treatment Quality assurance and economical aspects of laser material processing Markets and Applications of laser technology Student group exercises
Literature	<ul style="list-style-type: none"> Hügel, H. , T. Graf: Laser in der Fertigung : Strahlquellen, Systeme, Fertigungsverfahren, 3. Aufl., Vieweg + Teubner Wiesbaden 2014. Eichler, J., Eichler, H. J.: Laser: Bauformen, Strahlführung, Anwendungen, 7. Aufl., Springer-Verlag Berlin Heidelberg 2010. Steen W. M.; Mazumder J.: Laser material processing, 4th Edition, Springer-Verlag London 2010. J.C. Ion: Laser processing of engineering materials: principles, procedure and industrial applications, Elsevier Butterworth-Heinemann 2005. Gebhardt, A.: Understanding additive manufacturing, München [u.a.] Hanser 2011

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0876: Methods for Analysing Production Processes	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Modelling and simulation of machining and forming processes • Numerical simulation of forces, temperatures, deformation in machining • Analysis of vibration problems in machining (chatter, modal analysis,...) • Knowledge based process planning • Design of experiments • Machinability of nonmetallic materials • Analysis of interaction between machining process and machine tool systems with regard to process stability and quality • Simulation of machining processes by virtual reality methods
Literature	<p>Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004)</p> <p>Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006)</p> <p>Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001)</p> <p>Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)</p>

Module M1193: Cabin Systems Engineering			
Courses			
Title	Typ	Hrs/wk	CP
Computer and communication technology in cabin electronics and avionics (L1557)	Lecture	2	2
Computer and communication technology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1
Model-Based Systems Engineering (MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	3	3
Module Responsible	Prof. Ralf God		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems Previous knowledge in: <ul style="list-style-type: none"> • Systems Engineering 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • describe the structure and operation of computer architectures • explain the structure and operation of digital communication Networks • explain architectures of cabin electronics, integrated modular avionics (IMA) and Aircraft Data Communication Network (ADCN) • understand the approach of Model-Based Systems Engineering (MBSE) in the design of hardware and software-based cabin systems Students are able to: <ul style="list-style-type: none"> • understand, operate and maintain a Minicomputer • build up a network communication and communicate with other network participants • connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network • model system functions by means of formal languages SysML/UML and generate software code from the models • execute software code on a minicomputer Students are able to: <ul style="list-style-type: none"> • elaborate partial results and merge with others to form a complete solution Students are able to: <ul style="list-style-type: none"> • organize and schedule their practical tasks 		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 minutes		
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L1557: Computer and communication technology in cabin electronics and avionics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

Course L1558: Computer and communication technology in cabin electronics and avionics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

Course L1551: Model-Based Systems Engineering (MBSE) with SysML/UML	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	<p>Objectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages SysML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based Systems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):</p> <ul style="list-style-type: none"> • What is a model? • What is Systems Engineering? • Survey of MBSE methodologies • The modelling languages SysML /UML • Tools for MBSE • Best practices for MBSE • Requirements specification, functional architecture, specification of a solution • From model to software code • Validation and verification: XIL methods • Accompanying MBSE project
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - Weilkiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008 - Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

Module M0511: Electricity Generation from Wind and Hydro Power			
Courses			
Title	Typ	Hrs/wk	CP
Sustainability Management (L0007)	Lecture	2	1
Hydro Power Use (L0013)	Lecture	1	1
Wind Turbine Plants (L0011)	Lecture	2	3
Wind Energy Use - Focus Offshore (L0012)	Lecture	1	1
Module Responsible	Dr. Isabel Höfer		
Admission Requirements	None		
Recommended Previous Knowledge	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II, Module: Fundamentals of Fluid Mechanics		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedure in the implementation of renewable energy projects in countries outside Europe.</p> <p>Through active discussions of various topics within the seminar of the module, students improve their understanding and the application of the theoretical background and are thus able to transfer what they have learned in practice.</p> <p>Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate and assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can in compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects.</p> <p>Students can discuss scientific tasks subject-specificly and multidisciplinary within a seminar.</p> <p>Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of the lecture and to acquire the particular knowledge about the subject area.</p>		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	2.5 hours written exam + Presentation in sustainability management		
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0007: Sustainability Management	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	WiSe
Content	<p>The lecture sustainability management provide an insight into the various aspects and dimensions of sustainability. This content of the course is based on the foundations of environmental assessment; therefore the previous attendance of the lecture environmental assessment is recommended. Various valuation approaches for assessing environmental, economic and social aspects are presented. Their application and use for a sustainability management's discussion is explained by means of short technology examples and is later comprehensively presented through case examples.</p> <ul style="list-style-type: none"> • Introduction to the topic of sustainability • Dimensions of sustainability: <ul style="list-style-type: none"> ◦ ecology ◦ economics ◦ social • Transition from the environmental assessment for sustainability management • Case Studies • Excursion <p>Objective: The aim of the course is to learn methods for the assessment of sustainability aspects and apply for sustainability management.</p>
Literature	<p>Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage</p> <p>Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.</p>

Course L0013: Hydro Power Use	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner, Hugo Götsch
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Introduction, importance of water power in the national and global context • Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies • Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems • Construction of hydroelectric power plants: description of the individual components and their technical system interaction • Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. • Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection • Hydropower and the Environment • Examples from practice
Literature	<ul style="list-style-type: none"> • Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage • Quaschnig, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage • Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage • von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage • Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006

Course L0011: Wind Turbine Plants	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rudolf Zellermann, Dr. Jochen Oexmann
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Historical development • Wind: origins, geographic and temporal distribution, locations • Power coefficient, rotor thrust • Aerodynamics of the rotor • Operating performance • Power limitation, partial load, pitch and stall control • Plant selection, yield prediction, economy • Excursion
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005

Course L0012: Wind Energy Use - Focus Offshore	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering • Physical fundamentals for utilization of wind energy • Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships • Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures • Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection • Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics • Development and planning of offshore wind farms • Operation and optimization of offshore wind farms • Day excursion
Literature	<ul style="list-style-type: none"> • Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage • Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidelberg, 1997, 3. Auflage • Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4. Auflage • Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage • Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

Module M0630: Robotics and Navigation in Medicine				
Courses				
Title	Typ		Hrs/wk	CP
Robotics and Navigation in Medicine (L0335)	Lecture		2	3
Robotics and Navigation in Medicine (L0338)	Project Seminar		2	2
Robotics and Navigation in Medicine (L0336)	Recitation Section (small)		1	1
Module Responsible	Prof. Alexander Schlaefer			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> principles of math (algebra, analysis/calculus) principles of programming, e.g., in Java or C++ solid R or Matlab skills 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.</p> <p><i>Skills</i> The students are able to design and evaluate navigation systems and robotic systems for medical applications.</p>			
Personal Competence				
<i>Social Competence</i>	The students discuss the results of other groups, provide helpful feedback and can incorporate feedback into their work.			
<i>Autonomy</i>	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	10 %	Presentation	
	Yes	10 %	Written elaboration	
Examination	Written exam			
Examination duration and scale	90 minutes			
Assignment for the Following Curricula	<p>Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory</p> <p>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory</p>			

Course L0335: Robotics and Navigation in Medicine	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - kinematics - calibration - tracking systems - navigation and image guidance - motion compensation <p>The seminar extends and complements the contents of the lecture with respect to recent research results.</p>
Literature	<p>Spong et al.: Robot Modeling and Control, 2005</p> <p>Troccaz: Medical Robotics, 2012</p> <p>Further literature will be given in the lecture.</p>

Course L0338: Robotics and Navigation in Medicine	
Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0336: Robotics and Navigation in Medicine	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0764: Flight Control Systems (FS2)				
Courses				
Title			Typ	
Aircraft Systems II (L0736)			Lecture	3
Aircraft Systems II (L0740)			Recitation Section (large)	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	basic knowledge of: <ul style="list-style-type: none"> • mathematics • mechanics • thermo dynamics • electronics • fluid technology • control technology 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students are able to... <ul style="list-style-type: none"> • describe the structure of primary flight control systems as well as actuation-, avionic-, high lift systems in general along with corresponding properties and applications. • explain different configurations and designs and their origins • 			
<i>Skills</i>	Students are able to... <ul style="list-style-type: none"> • size primary flight control actuation systems • perform a controller design process for the flight control actuators • design high-lift kinematics 			
Personal Competence				
<i>Social Competence</i>	Students are able to: <ul style="list-style-type: none"> • Develop joint solutions in mixed teams 			
<i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • derive requirements and perform appropriate yet simplified design processes for aircraft systems from complex issues and circumstances in a self-reliant manner 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	165 Minutes			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0736: Aircraft Systems II	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems) • Flight Control Systems (control surfaces, hinge moments; requirements of stability and controllability, actuation power; principles of reversible and irreversible flight control systems; servo actuation systems) • Landing Gear Systems (Configurations and geometries; analysis of landing gear systems with respect to damper dynamics, dynamics of the breaking aircraft and power consumption; design and analysis of breaking systems with respect to energy and heat; anti-skid systems) • Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank) • De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)
Literature	<ul style="list-style-type: none"> • Moir, Seabridge: Aircraft Systems • Torenbek: Synthesis of Subsonic Airplane Design • Curry: Aircraft Landing Gear Design: Principles and Practices

Course L0740: Aircraft Systems II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0811: Medical Imaging Systems				
Courses				
Title	Typ		Hrs/wk	CP
Medical Imaging Systems (L0819)	Lecture		4	6
Module Responsible	Dr. Michael Grass			
Admission Requirements	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	<p>Students can:</p> <ul style="list-style-type: none"> Describe the system configuration and components of the main clinical imaging systems; Explain how the system components and the overall system of the imaging systems function; Explain and apply the physical processes that make imaging possible and use with the fundamental physical equations; Name and describe the physical effects required to generate image contrasts; Explain how spatial and temporal resolution can be influenced and how to characterize the images generated; Explain which image reconstruction methods are used to generate images; <p>Describe and explain the main clinical uses of the different systems.</p>			
<i>Skills</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required; <ul style="list-style-type: none"> Calculate the parameters of imaging systems using the mathematical or physical equations; Determine the influence of different system components on the spatial and temporal resolution of imaging systems; Explain the importance of different imaging systems for a number of clinical applications; <p>Select a suitable imaging system for an application.</p>			
Personal Competence <i>Social Competence</i>	none			
<i>Autonomy</i>	<p>Students can:</p> <ul style="list-style-type: none"> Understand which physical effects are used in medical imaging; Decide independently for which clinical issue a measuring system can be used. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	<p>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory</p> <p>Biomedical Engineering: Core Qualification: Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory</p>			

Course L0819: Medical Imaging Systems	
Typ	Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Dr. Michael Grass, Dr. Sven Prevrhal, Dr. Tim Nielsen, Frank Michael Weber
Language	DE
Cycle	SoSe
Content	
Literature	<p>Primary book:</p> <p>1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press</p> <p>Secondary books:</p> <ul style="list-style-type: none"> - A. Webb, "Introduction to Biomedical Imaging", IEEE Press 2003. - W.R. Hendee and E.R. Ritenour, "Medical Imaging Physics", Wiley-Liss, New York, 2002. - H. Morneburg (Edt), "Bildgebende Systeme für die medizinische Diagnostik", Erlangen: Siemens Publicis MCD Verlag, 1995. - O. Dössel, "Bildgebende Verfahren in der Medizin", Springer Verlag Berlin, 2000.

Module M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)

Courses

Title	Typ	Hrs/wk	CP
Applied Automation (L1592)	Project-/problem-based Learning	3	3
Ergonomics (L0653)	Lecture	2	3
Elements of Integrated Production Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
Innovation and Product Management (L2168)	Seminar	2	3
Lightweight Design Practical Course (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Processes of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Technology (L0664)	Lecture	2	3
Six Sigma (L1130)	Lecture	2	3
Structural Mechanics of Fibre Reinforced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Ceramics Technology (L0379)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics (L0176)	Lecture	2	2
Reliability in Engineering Dynamics (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L0749)	Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of product development, materials and production Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> - <i>Autonomy</i> <ul style="list-style-type: none"> Students are able to develop their knowledge and skills by autonomous election of courses. 			
Workload in Hours	Depends on choice of courses		
Credit points	12		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1592: Applied Automation	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> -Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy
Literature	<p>John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005</p> <p>Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010</p> <p>K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wiley & Sons, Inc., 1992</p>

Course L0653: Ergonomics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Armin Bossemeyer
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0927: Elements of Integrated Production Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	not available
Literature	<p>Harris, R.; Harris, C.; Wilson, E.: Making Materials Flow, Lean Enterprise Institute, Cambridge, 2003.</p> <p>Ohno, T.: Das Toyota-Produktionssystem, Campus-Verlag, Frankfurt et al, 1993.</p> <p>Rother, M.: Die Kata des Weltmarktführers. Toyotas Erfolgsmethoden, Campus-Verlag, Frankfurt et al, 2009.</p> <p>Rother, M.; Shook, J.: Sehen lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen, Lean Management Institut, Aachen, 2006.</p> <p>Rother, M.; Harris, R.: Creating Continuous Flow, Lean Enterprise Institute, Brookline, 2001.</p> <p>Shingo, S.: A Revolution in Manufacturing. The SMED System, Productivity Press, 2006.</p> <p>Womack, J. P. et al: Die zweite Revolution in der Autoindustrie, Frankfurt/New York, Campus Verlag, 1992.</p>

Course L1512: Development Management for Mechatronics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Johannes Nicolas Gebhardt, Dr. Daniel Steffen
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Processes and methods of product development - from idea to market launch <ul style="list-style-type: none"> identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development <ul style="list-style-type: none"> Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	<ul style="list-style-type: none"> Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

Course L0310: Fatigue & Damage Tolerance	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Martin Flamm
Language	EN
Cycle	WiSe
Content	Design principles, fatigue strength, crack initiation and crack growth, damage calculation, counting methods, methods to improve fatigue strength, environmental influences
Literature	Jaap Schijve, Fatigue of Structures and Materials. Kluwer Academic Publisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

Course L2012: Industry 4.0 for engineers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	120 min
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2168: Innovation and Product Management	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christoph Fuchs
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L1258: Lightweight Design Practical Course	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	<p>Development of a sandwich structure made of fibre reinforced plastics</p> <ul style="list-style-type: none"> • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion“, Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation“, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0950: Mechanisms, Systems and Processes of Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	<p>Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies</p> <ul style="list-style-type: none"> • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	<ul style="list-style-type: none"> • E. Macherauch: Praktikum in Werkstoffkunde, Vieweg • G. E. Dieter: Mechanical Metallurgy, McGraw-Hill • R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg • R. Bürgel: Werkstoffe sicher beurteilen und richtig einsetzen, Vieweg

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0724: Microsystems Technology	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction (historical view, scientific and economic relevance, scaling laws) • Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) • Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) • Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) • Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) • Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) • Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) • Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) • Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics) • MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration) • Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship) • System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	<p>M. Madou: Fundamentals of Microfabrication, CRC Press, 2002</p> <p>N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009</p> <p>T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010</p> <p>G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0928: Productivity Management	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Principles of productivity management • Shop floor management and standardisation • Takt analysis and design of manual operations • Maintenance Principles • Total Productive Maintenance (TPM) • Optimisation of set-up operations • Analysis of interlinked production systems
Literature	<p>Bokranz, R.; Landau, K.: Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.</p> <p>Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.</p> <p>Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.</p> <p>Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985</p>

Course L0931: Productivity Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0664: Feedback Control in Medical Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	<p>Always viewed from the engineer's point of view, the lecture is structured as follows:</p> <ul style="list-style-type: none"> • Introduction to the topic • Fundamentals of physiological modelling • Introduction to Breathing and Ventilation • Physiology and Pathology in Cardiology • Introduction to the Regulation of Blood Glucose • kidney function and renal replacement therapy • Representation of the control technology on the concrete ventilator • Excursion to a medical technology company <p>Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.</p>
Literature	<ul style="list-style-type: none"> • Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. • Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. • Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Course L1130: Six Sigma	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Claus Emmelmann
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction and structuring • Basic terms of quality management • Measuring and inspection equipment • Tools of quality management: FMEA, QFD, FTA, etc. • Quality management methodology Six Sigma, DMAIC
Literature	<p>Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008</p> <p>Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996</p> <p>Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008</p>

Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	<p>Classical laminate theory</p> <p>Rules of mixture</p> <p>Failure mechanisms and criteria of composites</p> <p>Boundary value problems of isotropic and anisotropic shells</p> <p>Stability of composite structures</p> <p>Optimization of laminated composites</p> <p>Modelling composites in FEM</p> <p>Numerical multiscale analysis of textile composites</p> <p>Progressive failure analysis</p>
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, aktuelle Auflage. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, , aktuelle Auflage. • Reddy, J.N., „Mechanics of Composite Laminated Plates and Shells“, CRC Publishing, Boca Raton et al., current edition. • Jones, R.M., „Mechanics of Composite Materials“, Scripta Book Co., Washington, current edition. • Timoshenko, S.P., Gere, J.M., „Theory of elastic stability“, McGraw-Hill Book Company, Inc., New York, current edition. • Turvey, G.J., Marshall, I.H., „Buckling and postbuckling of composite plates“, Chapman and Hall, London, current edition. • Herakovich, C.T., „Mechanics of fibrous composites“, John Wiley and Sons, Inc., New York, current edition. • Mittelstedt, C., Becker, W., „Strukturmechanik ebener Lamine“, aktuelle Auflage.

Course L1820: System Simulation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	<p>Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica.</p> <ul style="list-style-type: none"> • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	<p>[1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7</p> <p>[2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014.</p> <p>[3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</p> <p>[4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</p> <p>[5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1821: System Simulation	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Basics with analysis, concept, proposal drawings and sketches • Samples from practice of technical industrial design • Product concept with new ideas and package • ID proposal with structural concept and external product ergonomics • Visualisation and presentation of the overall concept • Realization as individual case studies
Literature	<p>Literatur über technisches Produktdesign</p> <p>Technisches Rendering und Präsentation</p> <p>Zeichnen und perspektivisches Entwerfen</p> <p>Literaturhinweise</p> <p>What is Product Design ?</p> <p>Laura Slack</p> <p>RotoVision Schweiz 2006</p> <p>Product Design Now</p> <p>Design and Scetches</p> <p>CollinsDesign and maomao publications Spanien 2006</p> <p>Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects,</p> <p>Watson, Gupta Publications,a division of Billboard Publications Inc., New York 1983</p> <p>Creative Techniques</p> <p>DRAWING</p> <p>Barons Educational Series</p> <p>ISBN-13: 978-0-7641-6182-7</p> <p>Joseph Ungar, Rendering In Mixed Media - Techniques for Concept</p> <p>Presentation for Designers and Illustrators</p> <p>Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985</p> <p>AIRWORLD</p> <p>Design und Architektur für die Flugreise</p> <p>Vitra Design Stiftung Weil am Rhein 2004</p>

	<p>Airline Design</p> <p>Perter Deslius Jacek Slaski te Neues 2005</p> <p>Technik und Sicherheit von Passagierflugzeugen</p> <p>Frank Littek</p> <p>Motorbuch Verlag 2003</p> <p>Jetliner Cabins</p> <p>Jennifer Coutts Clay</p> <p>Cs books England 2006</p> <p>BOEING Widebodies</p> <p>Michael Haenggi motorbooks international USA 2003</p> <p>form - Zeitschrift für Gestaltung, Verlag form GmbH,</p> <p>Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim</p> <p>(erscheint vierteljährlich, Verlag form GmbH)</p> <p>design report</p> <p>german magasin,</p> <p>(erscheint monatlich)</p> <p>md - möbel interior design, Konradin-Verlag</p> <p>Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen</p> <p>(erscheint monatlich)</p> <p>CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,</p> <p>Kitashinjuku, Shinjuku-ku, Tokio 160, Japan</p> <p>(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,</p> <p>Auto & Design,</p> <p>Corso Frabcia 161, 10139 Torino, Italia</p> <p>(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei</p> <p>Monate , erhältlich am HBF Hamburg</p> <p>AERO International,</p> <p>Magazin für Zivilluftfahrt</p> <p>(erscheint monatlich)</p> <p>Aircraft interior international</p> <p>Engl. magasin for Aircraft cabin interior</p> <p>(erscheint 2 monatlich)</p> <p>aerotec</p> <p>Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie</p>
--	---

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0379: Ceramics Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Rolf Janßen
Language	DE/EN
Cycle	WiSe
Content	<p>Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metallurgical techniques and sintering (solid state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed. Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.</p> <p>Content:</p> <ol style="list-style-type: none"> 1. Introduction 2. Raw materials 3. Powder fabrication 4. Powder processing 5. Shape-forming processes 6. Densification, sintering 7. Glass and Cement technology 8. Ceramic-metal joining techniques <p>Inhalt:</p>
Literature	<p>W.D. Kingery, „Introduction to Ceramics“, John Wiley & Sons, New York, 1975</p> <p>ASM Engineering Materials Handbook Vol.4 „Ceramics and Glasses“, 1991</p> <p>D.W. Richerson, „Modern Ceramic Engineering“, Marcel Dekker, New York, 1992</p> <p>Skript zur Vorlesung</p>

Course L0949: Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	<p>Application and analysis of basic mechanical as well as non-destructive testing of materials</p> <ul style="list-style-type: none"> • Determination elastic constants • Tensile test • Fatigue test (testing with constant stress, strain, or plastic strain amplitude, low and high cycle fatigue, mean stress effect) • Crack growth upon static loading (stress intensity factor, fracture toughness) • Creep test • Hardness test • Charpy impact test • Non destructive testing
Literature	<p>E. Macherauch: Praktikum in Werkstoffkunde, Vieweg</p> <p>G. E. Dieter: Mechanical Metallurgy, McGraw-Hill</p>

Course L0176: Reliability in Engineering Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min.
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	<p>Method for calculation and testing of reliability of dynamic machine systems</p> <ul style="list-style-type: none"> • Modeling • System identification • Simulation • Processing of measurement data • Damage accumulation • Test planning and execution
Literature	<p>Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4</p> <p>Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737</p> <p>Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.</p> <p>VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412</p>

Course L1303: Reliability in Engineering Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0749: Reliability of Aircraft Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wiecek
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Functions of reliability and safety (regulations, certification requirements) • Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment) • Reliability analysis of electrical and mechanical systems
Literature	<ul style="list-style-type: none"> • CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1156: Systems Engineering				
Courses				
Title	Typ		Hrs/wk	CP
Systems Engineering (L1547)	Lecture		3	4
Systems Engineering (L1548)	Recitation Section (large)		1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous Knowledge	<p>Basic knowledge in:</p> <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems <p>Previous knowledge in:</p> <ul style="list-style-type: none"> • Aircraft Cabin Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> • understand systems engineering process models, methods and tools for the development of complex Systems • describe innovation processes and the need for technology Management • explain the aircraft development process and the process of type certification for aircraft • explain the system development process, including requirements for systems reliability • identify environmental conditions and test procedures for airborne Equipment • value the methodology of requirements-based engineering (RBE) and model-based requirements engineering (MBRE) <p>Students are able to:</p> <ul style="list-style-type: none"> • plan the process for the development of complex Systems • organize the development phases and development Tasks • assign required business activities and technical Tasks • apply systems engineering methods and tools <p>Students are able to:</p> <ul style="list-style-type: none"> • understand their responsibilities within a development team and integrate themselves with their role in the overall process <p>Students are able to:</p> <ul style="list-style-type: none"> • interact and communicate in a development team which has distributed tasks 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes			
Assignment for the Following Curricula	<p>Aircraft Systems Engineering: Core Qualification: Compulsory</p> <p>International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory</p> <p>Mechatronics: Specialisation System Design: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory</p>			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1547: Systems Engineering	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	<p>The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known.</p> <p>Key aspects of the course are processes for innovation and technology management, system design, system integration and certification as well as tools and methods for systems engineering:</p> <ul style="list-style-type: none"> • Innovation processes • IP-protection • Technology management • Systems engineering • Aircraft program • Certification issues • Systems development • Safety objectives and fault tolerance • Environmental and operating conditions • Tools for systems engineering • Requirements-based engineering (RBE) • Model-based requirements engineering (MBRE)
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE) - Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010 - NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007 - Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010 - De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010 - Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt.Verlag, 2008

Course L1548: Systems Engineering	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1161: Turbomachinery				
Courses				
Title	Typ		Hrs/wk	CP
Turbomachines (L1562)	Lecture		3	4
Turbomachines (L1563)	Recitation Section (large)		1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous Knowledge	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	<p>The students can</p> <ul style="list-style-type: none"> distinguish the physical phenomena of conversion of energy, understand the different mathematic modelling of turbomachinery, calculate and evaluate turbomachinery. 			
<i>Skills</i>	<p>The students are able to</p> <ul style="list-style-type: none"> understand the physics of Turbomachinery, solve excersises self-consistent. 			
Personal Competence				
<i>Social Competence</i>	<p>The students are able to</p> <ul style="list-style-type: none"> discuss in small groups and develop an approach. 			
<i>Autonomy</i>	<p>The students are able to</p> <ul style="list-style-type: none"> develop a complex problem self-consistent, analyse the results in a critical way, have an qualified exchange with other students. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	<p>Energy Systems: Specialisation Energy Systems: Elective Compulsory</p> <p>Energy Systems: Specialisation Marine Engineering: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p>			

Course L1562: Turbomachines	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Markus Schatz
Language	DE
Cycle	SoSe
Content	<p>Topics to be covered will include:</p> <ul style="list-style-type: none"> Application cases of turbomachinery Fundamentals of thermodynamics and fluid mechanics Design fundamentals of turbomachinery Introduction to the theory of turbine stage Design and operation of the turbocompressor Design and operation of the steam turbine Design and operation of the gas turbine Physical limits of the turbomachines
Literature	<ul style="list-style-type: none"> Traupel: Thermische Turbomaschinen, Springer. Berlin, Heidelberg, New York Bräunling: Flugzeuggasturbinen, Springer., Berlin, Heidelberg, New York Seume: Stationäre Gasturbinen, Springer., Berlin, Heidelberg, New York Menny: Strömungsmaschinen, Teubner., Stuttgart

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1563: Turbomachines	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Markus Schatz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)			
Courses			
Title	Typ	Hrs/wk	CP
Applied Automation (L1592)	Project-/problem-based Learning	3	3
Ergonomics (L0653)	Lecture	2	3
Elements of Integrated Production Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
Innovation and Product Management (L2168)	Seminar	2	3
Lightweight Design Practical Course (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Processes of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Technology (L0664)	Lecture	2	3
Six Sigma (L1130)	Lecture	2	3
Structural Mechanics of Fibre Reinforced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Ceramics Technology (L0379)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics (L0176)	Lecture	2	2
Reliability in Engineering Dynamics (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L0749)	Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of product development, materials and production Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> - <i>Autonomy</i> <ul style="list-style-type: none"> Students are able to develop their knowledge and skills by autonomous election of courses. 			
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1592: Applied Automation	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> -Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy
Literature	<p>John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005</p> <p>Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010</p> <p>K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wiley & Sons, Inc., 1992</p>

Course L0653: Ergonomics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Armin Bossemeyer
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0927: Elements of Integrated Production Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	not available
Literature	<p>Harris, R.; Harris, C.; Wilson, E.: Making Materials Flow, Lean Enterprise Institute, Cambridge, 2003.</p> <p>Ohno, T.: Das Toyota-Produktionssystem, Campus-Verlag, Frankfurt et al, 1993.</p> <p>Rother, M.: Die Kata des Weltmarktführers. Toyotas Erfolgsmethoden, Campus-Verlag, Frankfurt et al, 2009.</p> <p>Rother, M.; Shook, J.: Sehen lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen, Lean Management Institut, Aachen, 2006.</p> <p>Rother, M.; Harris, R.: Creating Continuous Flow, Lean Enterprise Institute, Brookline, 2001.</p> <p>Shingo, S.: A Revolution in Manufacturing. The SMED System, Productivity Press, 2006.</p> <p>Womack, J. P. et al: Die zweite Revolution in der Autoindustrie, Frankfurt/New York, Campus Verlag, 1992.</p>

Course L1512: Development Management for Mechatronics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Johannes Nicolas Gebhardt, Dr. Daniel Steffen
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Processes and methods of product development - from idea to market launch <ul style="list-style-type: none"> identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development <ul style="list-style-type: none"> Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	<ul style="list-style-type: none"> Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

Course L0310: Fatigue & Damage Tolerance	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Martin Flamm
Language	EN
Cycle	WiSe
Content	Design principles, fatigue strength, crack initiation and crack growth, damage calculation, counting methods, methods to improve fatigue strength, environmental influences
Literature	Jaap Schijve, Fatigue of Structures and Materials. Kluwer Academic Publisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

Course L2012: Industry 4.0 for engineers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	120 min
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2168: Innovation and Product Management	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christoph Fuchs
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Course L1258: Lightweight Design Practical Course	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	<p>Development of a sandwich structure made of fibre reinforced plastics</p> <ul style="list-style-type: none"> • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion“, Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation“, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0950: Mechanisms, Systems and Processes of Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	<p>Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies</p> <ul style="list-style-type: none"> • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	<ul style="list-style-type: none"> • E. Macherauch: Praktikum in Werkstoffkunde, Vieweg • G. E. Dieter: Mechanical Metallurgy, McGraw-Hill • R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg • R. Bürgel: Werkstoffe sicher beurteilen und richtig einsetzen, Vieweg

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0724: Microsystems Technology	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction (historical view, scientific and economic relevance, scaling laws) • Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) • Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) • Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) • Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) • Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) • Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) • Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) • Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics) • MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration) • Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship) • System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	<p>M. Madou: Fundamentals of Microfabrication, CRC Press, 2002</p> <p>N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009</p> <p>T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010</p> <p>G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0928: Productivity Management	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Principles of productivity management • Shop floor management and standardisation • Takt analysis and design of manual operations • Maintenance Principles • Total Productive Maintenance (TPM) • Optimisation of set-up operations • Analysis of interlinked production systems
Literature	<p>Bokranz, R.; Landau, K.: Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.</p> <p>Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.</p> <p>Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.</p> <p>Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985</p>

Course L0931: Productivity Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0664: Feedback Control in Medical Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	<p>Always viewed from the engineer's point of view, the lecture is structured as follows:</p> <ul style="list-style-type: none"> • Introduction to the topic • Fundamentals of physiological modelling • Introduction to Breathing and Ventilation • Physiology and Pathology in Cardiology • Introduction to the Regulation of Blood Glucose • kidney function and renal replacement therapy • Representation of the control technology on the concrete ventilator • Excursion to a medical technology company <p>Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.</p>
Literature	<ul style="list-style-type: none"> • Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. • Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. • Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Course L1130: Six Sigma	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Claus Emmelmann
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction and structuring • Basic terms of quality management • Measuring and inspection equipment • Tools of quality management: FMEA, QFD, FTA, etc. • Quality management methodology Six Sigma, DMAIC
Literature	<p>Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008</p> <p>Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996</p> <p>Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008</p>

Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	<p>Classical laminate theory</p> <p>Rules of mixture</p> <p>Failure mechanisms and criteria of composites</p> <p>Boundary value problems of isotropic and anisotropic shells</p> <p>Stability of composite structures</p> <p>Optimization of laminated composites</p> <p>Modelling composites in FEM</p> <p>Numerical multiscale analysis of textile composites</p> <p>Progressive failure analysis</p>
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, aktuelle Auflage. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, , aktuelle Auflage. • Reddy, J.N., „Mechanics of Composite Laminated Plates and Shells“, CRC Publishing, Boca Raton et al., current edition. • Jones, R.M., „Mechanics of Composite Materials“, Scripta Book Co., Washington, current edition. • Timoshenko, S.P., Gere, J.M., „Theory of elastic stability“, McGraw-Hill Book Company, Inc., New York, current edition. • Turvey, G.J., Marshall, I.H., „Buckling and postbuckling of composite plates“, Chapman and Hall, London, current edition. • Herakovich, C.T., „Mechanics of fibrous composites“, John Wiley and Sons, Inc., New York, current edition. • Mittelstedt, C., Becker, W., „Strukturmechanik ebener Laminate“, aktuelle Auflage.

Course L1820: System Simulation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	<p>Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica.</p> <ul style="list-style-type: none"> • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	<p>[1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7</p> <p>[2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014.</p> <p>[3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</p> <p>[4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</p> <p>[5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1821: System Simulation	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Basics with analysis, concept, proposal drawings and sketches • Samples from practice of technical industrial design • Product concept with new ideas and package • ID proposal with structural concept and external product ergonomics • Visualisation and presentation of the overall concept • Realization as individual case studies
Literature	<p>Literatur über technisches Produktdesign</p> <p>Technisches Rendering und Präsentation</p> <p>Zeichnen und perspektivisches Entwerfen</p> <p>Literaturhinweise</p> <p>What is Product Design ?</p> <p>Laura Slack</p> <p>RotoVision Schweiz 2006</p> <p>Product Design Now</p> <p>Design and Scetches</p> <p>CollinsDesign and maomao publications Spanien 2006</p> <p>Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects,</p> <p>Watson, Gupta Publications,a division of Billboard Publications Inc., New York 1983</p> <p>Creative Techniques</p> <p>DRAWING</p> <p>Barons Educational Series</p> <p>ISBN-13: 978-0-7641-6182-7</p> <p>Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators</p> <p>Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985</p> <p>AIRWORLD</p> <p>Design und Architektur für die Flugreise</p> <p>Vitra Design Stiftung Weil am Rhein 2004</p>

	<p>Airline Design</p> <p>Perter Deslius Jacek Slaski te Neues 2005</p> <p>Technik und Sicherheit von Passagierflugzeugen</p> <p>Frank Littek</p> <p>Motorbuch Verlag 2003</p> <p>Jetliner Cabins</p> <p>Jennifer Coutts Clay</p> <p>Cs books England 2006</p> <p>BOEING Widebodies</p> <p>Michael Haenggi motorbooks international USA 2003</p> <p>form - Zeitschrift für Gestaltung, Verlag form GmbH,</p> <p>Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim</p> <p>(erscheint vierteljährlich, Verlag form GmbH)</p> <p>design report</p> <p>german magasin,</p> <p>(erscheint monatlich)</p> <p>md - möbel interior design, Konradin-Verlag</p> <p>Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen</p> <p>(erscheint monatlich)</p> <p>CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,</p> <p>Kitashinjuku, Shinjuku-ku, Tokio 160, Japan</p> <p>(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,</p> <p>Auto & Design,</p> <p>Corso Frabcia 161, 10139 Torino, Italia</p> <p>(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei</p> <p>Monate , erhältlich am HBF Hamburg</p> <p>AERO International,</p> <p>Magazin für Zivilluftfahrt</p> <p>(erscheint monatlich)</p> <p>Aircraft interior international</p> <p>Engl. magasin for Aircraft cabin interior</p> <p>(erscheint 2 monatlich)</p> <p>aerotec</p> <p>Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie</p>
--	---

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0379: Ceramics Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Rolf Janßen
Language	DE/EN
Cycle	WiSe
Content	<p>Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metallurgical techniques and sintering (solid state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed. Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.</p> <p>Content:</p> <ol style="list-style-type: none"> 1. Introduction 2. Raw materials 3. Powder fabrication 4. Powder processing 5. Shape-forming processes 6. Densification, sintering 7. Glass and Cement technology 8. Ceramic-metal joining techniques <p>Inhalt:</p>
Literature	<p>W.D. Kingery, „Introduction to Ceramics“, John Wiley & Sons, New York, 1975</p> <p>ASM Engineering Materials Handbook Vol.4 „Ceramics and Glasses“, 1991</p> <p>D.W. Richerson, „Modern Ceramic Engineering“, Marcel Dekker, New York, 1992</p> <p>Skript zur Vorlesung</p>

Course L0949: Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	<p>Application and analysis of basic mechanical as well as non-destructive testing of materials</p> <ul style="list-style-type: none"> • Determination elastic constants • Tensile test • Fatigue test (testing with constant stress, strain, or plastic strain amplitude, low and high cycle fatigue, mean stress effect) • Crack growth upon static loading (stress intensity factor, fracture toughness) • Creep test • Hardness test • Charpy impact test • Non destructive testing
Literature	<p>E. Macherauch: Praktikum in Werkstoffkunde, Vieweg</p> <p>G. E. Dieter: Mechanical Metallurgy, McGraw-Hill</p>

Course L0176: Reliability in Engineering Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min.
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	<p>Method for calculation and testing of reliability of dynamic machine systems</p> <ul style="list-style-type: none"> • Modeling • System identification • Simulation • Processing of measurement data • Damage accumulation • Test planning and execution
Literature	<p>Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4</p> <p>Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737</p> <p>Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.</p> <p>VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412</p>

Course L1303: Reliability in Engineering Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0749: Reliability of Aircraft Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wiecek
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Functions of reliability and safety (regulations, certification requirements) • Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment) • Reliability analysis of electrical and mechanical systems
Literature	<ul style="list-style-type: none"> • CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1226: Mechanical Properties			
Courses			
Title	Typ	Hrs/wk	CP
Mechanical Behaviour of Brittle Materials (L1661)	Lecture	2	3
Dislocation Theory of Plasticity (L1662)	Lecture	2	3
Module Responsible	Dr. Erica Lilleodden		
Admission Requirements	None		
Recommended Previous Knowledge	Basics in Materials Science I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p>Students can explain basic principles of crystallography, statics (free body diagrams, tractions) and thermodynamics (energy minimization, energy barriers, entropy)</p> <p>Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations</p> <p>Students can provide appropriate feedback and handle feedback on their own performance constructively.</p> <p>Students are able to</p> <ul style="list-style-type: none"> - assess their own strengths and weaknesses - assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers. - work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed 		
<i>Knowledge</i>			
<i>Skills</i>			
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	<p>Materials Science: Core Qualification: Compulsory</p> <p>Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p>		

Course L1661: Mechanical Behaviour of Brittle Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider
Language	DE/EN
Cycle	SoSe
Content	<p>Theoretical Strength Of a perfect crystalline material, theoretical critical shear stress</p> <p>Real strength of brittle materials Energy release reate, stress intensity factor, fracture criterion</p> <p>Scattering of strength of brittle materials Defect distribution, strength distribution, Weibull distribution</p> <p>Heterogeneous materials I Internal stresses, micro cracks, weight function,</p> <p>Heterogeneous materials II Toughening mechanisms: crack bridging, fibres</p> <p>Heterogeneous materials III Toughening mechanisms. Process zone</p> <p>Testing methods to determine the fracture toughness of brittle materials</p> <p>R-curve, stable/unstable crack growth, fractography</p> <p>Thermal shock</p> <p>Subcritical crack growth) v-K-curve, life time prediction</p> <p>Kriechen</p> <p>Mechanical properties of biological materials</p> <p>Examples of use for a mechanically reliable design of ceramic components</p>
Literature	<p>D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elsevier</p> <p>D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998</p> <p>B.R. Lawn, Fracture of Brittle Solids", Cambridge University Press, 1993</p> <p>D. Munz, T. Fett, Ceramics, Springer, 2001</p> <p>D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992</p>

Course L1662: Dislocation Theory of Plasticity	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Erica Lilleodden
Language	DE/EN
Cycle	SoSe
Content	<p>This class will cover the principles of dislocation theory from a physical metallurgy perspective, providing a fundamental understanding of the relations between the strength and of crystalline solids and distributions of defects.</p> <p>We will review the concept of dislocations, defining terminology used, and providing an overview of important concepts (e.g. linear elasticity, stress-strain relations, and stress transformations) for theory development. We will develop the theory of dislocation plasticity through derived stress-strain fields, associated self-energies, and the induced forces on dislocations due to internal and externally applied stresses. Dislocation structure will be discussed, including core models, stacking faults, and dislocation arrays (including grain boundary descriptions). Mechanisms of dislocation multiplication and strengthening will be covered along with general principles of creep and strain rate sensitivity. Final topics will include non-FCC dislocations, emphasizing the differences in structure and corresponding implications on dislocation mobility and macroscopic mechanical behavior; and dislocations in finite volumes.</p>
Literature	<p>Vorlesungsskript</p> <p>Aktuelle Publikationen</p> <p>Bücher:</p> <p>Introduction to Dislocations, by D. Hull and D.J. Bacon</p> <p>Theory of Dislocations, by J.P. Hirth and J. Lothe</p> <p>Physical Metallurgy, by Peter Hassen</p>

Module M0840: Optimal and Robust Control			
Courses			
Title	Typ	Hrs/wk	CP
Optimal and Robust Control (L0658)	Lecture	2	3
Optimal and Robust Control (L0659)	Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner		
Admission Requirements	None		
Recommended Previous Knowledge	<ul style="list-style-type: none"> Classical control (frequency response, root locus) State space methods Linear algebra, singular value decomposition 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students can explain the significance of the matrix Riccati equation for the solution of LQ problems. They can explain the duality between optimal state feedback and optimal state estimation. They can explain how the H2 and H-infinity norms are used to represent stability and performance constraints. They can explain how an LQG design problem can be formulated as special case of an H2 design problem. They can explain how model uncertainty can be represented in a way that lends itself to robust controller design They can explain how - based on the small gain theorem - a robust controller can guarantee stability and performance for an uncertain plant. They understand how analysis and synthesis conditions on feedback loops can be represented as linear matrix inequalities. <i>Skills</i> <ul style="list-style-type: none"> Students are capable of designing and tuning LQG controllers for multivariable plant models. They are capable of representing a H2 or H-infinity design problem in the form of a generalized plant, and of using standard software tools for solving it. They are capable of translating time and frequency domain specifications for control loops into constraints on closed-loop sensitivity functions, and of carrying out a mixed-sensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain system, and of designing a mixed-objective robust controller. They are capable of formulating analysis and synthesis conditions as linear matrix inequalities (LMI), and of using standard LMI-solvers for solving them. They can carry out all of the above using standard software tools (Matlab robust control toolbox). Personal Competence <i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions. <i>Autonomy</i> Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Oral exam		
Examination duration and scale	30 min		
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0658: Optimal and Robust Control	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Optimal regulator problem with finite time horizon, Riccati differential equation • Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system • Kalman's identity, phase margin of LQR controllers, spectral factorization • Optimal state estimation, Kalman filter, LQG control • Generalized plant, review of LQG control • Signal and system norms, computing H_2 and H_∞ norms • Singular value plots, input and output directions • Mixed sensitivity design, H_∞ loop shaping, choice of weighting filters • Case study: design example flight control • Linear matrix inequalities, design specifications as LMI constraints (H_2, H_∞ and pole region) • Controller synthesis by solving LMI problems, multi-objective design • Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty
Literature	<ul style="list-style-type: none"> • Werner, H., Lecture Notes: "Optimale und Robuste Regelung" • Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 • Skogestad, S. and I. Postlewaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 • Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 • Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998

Course L0659: Optimal and Robust Control	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1343: Fibre-polymer-composites			
Courses			
Title	Typ	Hrs/wk	CP
Structure and properties of fibre-polymer-composites (L1894)	Lecture	2	3
Design with fibre-polymer-composites (L1893)	Lecture	2	3
Module Responsible	Prof. Bodo Fiedler		
Admission Requirements	None		
Recommended Previous Knowledge	Basics: chemistry / physics / materials science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis.</p> <p>They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection).</p> <p>Students are capable of</p> <ul style="list-style-type: none"> • using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. • approximate sizing using the network theory of the structural elements implement and evaluate. • selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance. <p>Students can</p> <ul style="list-style-type: none"> • arrive at funded work results in heterogenius groups and document them. • provide appropriate feedback and handle feedback on their own performance constructively. <p>Students are able to</p> <ul style="list-style-type: none"> - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 min		
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory		

Course L1894: Structure and properties of fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - Microstructure and properties of the matrix and reinforcing materials and their interaction - Development of composite materials - Mechanical and physical properties - Mechanics of Composite Materials - Laminate theory - Test methods - Non destructive testing - Failure mechanisms - Theoretical models for the prediction of properties - Application
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press Mallick: Fibre-Reinforced Composites, Marcel Dekker, New York

Course L1893: Design with fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	Designing with Composites: Laminate Theory; Failure Criteria; Design of Pipes and Shafts; Sandwich Structures; Notches; Joining Techniques; Compression Loading; Examples
Literature	Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag

Module M1344: Processing of fibre-polymer-composites			
Courses			
Title		Typ	Hrs/wk
Processing of fibre-polymer-composites (L1895)		Lecture	2
From Molecule to Composites Part (L1516)		Project-/problem-based Learning	2
Module Responsible	Prof. Bodo Fiedler		
Admission Requirements	None		
Recommended Previous Knowledge	Knowledge in the basics of chemistry / physics / materials science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	Students are able to give a summary of the technical details of the manufacturing processes composites and illustrate respective relationships. They are capable of describing and communicating relevant problems and questions using appropriate technical language. They can explain the typical process of solving practical problems and present related results.		
<i>Skills</i>	Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents (fiber / matrix) and define the necessary testing and analysis. They can explain the complex structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection).		
Personal Competence			
<i>Social Competence</i>	Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the context of civil engineering. They are able to effectively present and explain their results alone or in groups in front of a qualified audience. Students have the ability to develop alternative approaches to an engineering problem independently or in groups and discuss advantages as well as drawbacks.		
<i>Autonomy</i>	Students are capable of independently solving mechanical engineering problems using provided literature. They are able to fill gaps in as well as extent their knowledge using the literature and other sources provided by the supervisor. Furthermore, they can meaningfully extend given problems and pragmatically solve them by means of corresponding solutions and concepts.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Course L1895: Processing of fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	Manufacturing of Composites: Hand Lay-Up; Pre-Preg; GMT, BMC; SMC, RIM; Pultrusion; Filament Winding
Literature	Åström: Manufacturing of Polymer Composites, Chapman and Hall

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1516: From Molecule to Composites Part	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	<p>Students get the task in the form of a customer request for the development and production of a MTB handlebar made of fiber composites. In the task technical and normative requirements (standards) are given, all other required information come from the lectures and tutorials, and the respective documents (electronically and in conversation).</p> <p>The procedure is to specify in a milestone schedule and allows students to plan tasks and to work continuously. At project end, each group has a made handlebar with approved quality.</p> <p>In each project meeting the design (discussion of the requirements and risks) are discussed. The calculations are analyzed, evaluated and established manufacturing methods are selected. Materials are selected bar will be produced. The quality and the mechanical properties are checked. At the end of the final report created (compilation of the results for the "customers").</p> <p>After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.</p>
Literature	Customer Request ("Handout")

Module M1174: Automation Technology and Systems								
Courses								
Title		Typ	Hrs/wk	CP				
Automation Technology and Systems (L2329)		Lecture	4	4				
Automation Technology and Systems (L2331)		Project-/problem-based Learning	1	1				
Automation Technology and Systems (L2330)		Recitation Section (small)	1	1				
Module Responsible	Prof. Thorsten Schüppstuhl							
Admission Requirements	None							
Recommended Previous Knowledge	without major course assessment							
Educational Objectives	After taking part successfully, students have reached the following learning results							
Professional Competence	<div><div>Knowledge</div><div>Students<ul style="list-style-type: none">know the characteristic components of an automation systems and have good understanding of their interactionknow methods for a systematical analysis of automation tasks and are able to use themhave special competences in industrial robot based automation systems</div><div>Skills</div><div>Students are able to...<ul style="list-style-type: none">analyze complex Automation tasksdevelop application based concepts and solutionsdesign subsystems and integrate into one systeminvestigate and evaluate safety of machinerycreate simple programs for robots and programmable logic controllersdesign of circuit for pneumatic applications</div><div>Personal Competence</div><div><div>Social Competence</div><div>Students are able to ...<ul style="list-style-type: none">find solutions for automation and handling tasks in groupsdevelop solutions in a production environment with qualified personnel at technical level and represent decisions.</div><div>Autonomy</div><div>Students are able to ...<ul style="list-style-type: none">analyze automation tasks independentlygenerate programs for robots and programmable logic devices autonomouslydevelop solutions for practice oriented tasks of automation independentlydesign safety concepts for automation applicationsassess consequences of their professional actions and responsibilities</div></div></div>							
Workload in Hours					Independent Study Time 96, Study Time in Lecture 84			
Credit points					6			
Course achievement					None			
Examination					Written exam			
Examination duration and scale					120 min			
Assignment for the Following Curricula					Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Course L2329: Automation Technology and Systems	
Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2331: Automation Technology and Systems	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2330: Automation Technology and Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0563: Robotics			
Courses			
Title	Typ	Hrs/wk	CP
Robotics: Modelling and Control (L0168)	Integrated Lecture	4	4
Robotics: Modelling and Control (L1305)	Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of electrical engineering Broad knowledge of mechanics Fundamentals of control theory		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to describe fundamental properties of robots and solution approaches for multiple problems in robotics. Students are able to derive and solve equations of motion for various manipulators. Students can generate trajectories in various coordinate systems. Students can design linear and partially nonlinear controllers for robotic manipulators. Students are able to work goal-oriented in small mixed groups. Students are able to recognize and improve knowledge deficits independently. With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory		

Course L0168: Robotics: Modelling and Control	
Typ	Integrated Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Dr. Martin Gomse
Language	EN
Cycle	WiSe
Content	Fundamental kinematics of rigid body systems Newton-Euler equations for manipulators Trajectory generation Linear and nonlinear control of robots
Literature	Craig, John J.: Introduction to Robotics Mechanics and Control, Third Edition, Prentice Hall. ISBN 0201-54361-3 Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M. : Robot Modeling and Control. WILEY. ISBN 0-471-64990-2

Course L1305: Robotics: Modelling and Control	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Martin Gomse
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0771: Flight Physics				
Courses				
Title		Typ	Hrs/wk	CP
Aerodynamics and Flight Mechanics I (L0727)		Lecture	3	3
Flight Mechanics II (L0730)		Lecture	2	2
Flight Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none">• Mathematics• Mechanics• Thermodynamics• Aviation			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes (WS) + 90 Minutes (SS)			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0727: Aerodynamics and Flight Mechanics I	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich, Mike Montel
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none">• Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows)• Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)
Literature	<ul style="list-style-type: none">• Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II• Etkin, B.: Dynamics of Atmospheric Flight• Sachs/Hafer: Flugmechanik• Brockhaus: Flugregelung• J.D. Anderson: Introduction to flight

Course L0730: Flight Mechanics II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • stationary asymmetric flight • dynamics of lateral movement • methods of flight simulation • experimental methods of flight mechanics • model validation using system identification • wind tunnel techniques
Literature	<ul style="list-style-type: none"> • Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II • Etkin, B.: Dynamics of Atmospheric Flight • Sachs/Hafer: Flugmechanik • Brockhaus: Flugregelung • J.D. Anderson: Introduction to flight

Course L0731: Flight Mechanics II	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0815: Product Planning				
Courses				
Title			Typ	Hrs/wk CP
Product Planning (L0851)			Lecture	3 3
Product Planning Seminar (L0853)			Project-/problem-based Learning	2 3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Good basic-knowledge of Business Administration			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students will gain insights into:			
	<ul style="list-style-type: none"> Product Planning <ul style="list-style-type: none"> Process Methods Design thinking <ul style="list-style-type: none"> Process Methods User integration 			
<i>Skills</i>	Students will gain deep insights into:			
	<ul style="list-style-type: none"> Product Planning <ul style="list-style-type: none"> Process-related aspects Organisational-related aspects Human-Ressource related aspects Working-tools, methods and instruments 			
Personal Competence				
<i>Social Competence</i>	<ul style="list-style-type: none"> Interact within a team Raise awareness for globabl issues 			
<i>Autonomy</i>	<ul style="list-style-type: none"> Gain access to knowledge sources Interpret complex cases Develop presentation skills 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	20 %	Subject	theoretical and practical work
Examination	Written exam			
Examination duration and scale	90 minutes			
Assignment for the Following Curricula	Global Innovation Management: Core Qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0851: Product Planning	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	<p>Product Planning Process</p> <p>This integrated lecture is designed to understand major issues, activities and tools in the context of systematic product planning, a key activity for managing the front-end of innovation, i.e.:</p> <ul style="list-style-type: none"> • Systematic scanning of markets for innovation opportunities • Understanding strengths/weakness and specific core competences of a firm as platforms for innovation • Exploring relevant sources for innovation (customers, suppliers, Lead Users, etc.) • Developing ideas for radical innovation, relying on the creativeness of employees, using techniques to stimulate creativity and creating a stimulating environment • Transferring ideas for innovation into feasible concepts which have a high market attractively <p>Voluntary presentations in the third hour (articles / case studies)</p> <ul style="list-style-type: none"> - Guest lectures by researchers - Lecture on Sustainability with frequent reference to current research - Permanent reference to current research <p>Examination:</p> <p>In addition to the written exam at the end of the module, students have to attend the PBL-exercises and prepare presentations in groups in order to pass the module. Additionally, students have the opportunity to present research papers on a voluntary base. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.</p>
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010

Course L0853: Product Planning Seminar	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Seminar is integrative part of the Module Product Planning (for content see lecture) and can not be chosen independantly.
Literature	See lecture information "Product Planning".

Module M0830: Environmental Protection and Management				
Courses				
Title		Typ	Hrs/wk	CP
Integrated Pollution Control (L0502)		Lecture	2	2
Health, Safety and Environmental Management (L0387)		Lecture	2	3
Health, Safety and Environmental Management (L0388)		Recitation Section (small)	1	1
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none">• Good knowledge in Technologies for Environmental Protection (end-of-pipe, integrated solutions)• Good knowledge of the relevant Environmental Legislation• Basic knowledge of instruments for Environmental Assessment			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	Knowledge	The students are able to describe the basics of regulations, economic instruments, voluntary initiatives, fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements. They can analyse and discuss industrial processes, substance cycles and approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their sound knowledge of complex industry related problems. They are able to judge environmental issues and to widely consider, apply or carry out innovative technical solutions, remediation measures and further interventions as well as conceptual problem solving approaches in the full range of problems in different industrial sectors.		
	Skills	Students are able to assess current problems and situations in the field of environmental protection. They can consider the best available techniques and to plan and suggest concrete actions in a company- or branch-specific context. By this means they can solve problems on a technical, administrative and legislative level.		
	Personal Competence			
	Social Competence	The students can work together in international groups.		
Autonomy	Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. They can acquire appropriate knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory Environmental Engineering: Core Qualification: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Energy: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Compulsory			

Course L0502: Integrated Pollution Control	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<p>The lecture focusses on:</p> <ul style="list-style-type: none"> • The Regulatory Framework • Pollution & Impacts, Characteristics of Pollutants • Approaches of Integrated Pollution Control • Sevilla Process, Best Available Technologies & BREF Documents • Case Studies: paper industry, cement industry, automotive industry • Field Trip
Literature	<p>Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0</p> <p>Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3</p>

Course L0387: Health, Safety and Environmental Management	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Objectives of and benefit from HSE management • From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives • Fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements Environmental performance evaluation Risk management: hazard, risk and safety Health and safety at the workplace • Crisis management
Literature	<p>C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315)</p> <p>Exercises can be downloaded from StudIP</p>

Course L0388: Health, Safety and Environmental Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0962: Sustainability and Risk Management				
Courses				
Title		Typ	Hrs/wk	CP
Safety, Reliability and Risk Assessment (L1145)		Seminar	2	3
Environment and Sustainability (L0319)		Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<div>Knowledge</div> <p>Students are able to describe single techniques and to give an overview for the field of safety and risk assessment as well as environmental and sustainable engineering, in detail:</p> <ul style="list-style-type: none">basics in safety and reliability of technical facilitiessafety and reliability analysis methodsrisk assessmentProduction and usage of bio-charenergy production and supplysustainable product design <div>Skills</div> <p>Students are able apply interdisciplinary system-oriented methods for risk assessment and sustainability reporting. They can evaluate the effort and costs for processes and select economically feasible treatment concepts.</p> <div>Personal Competence</div> <div>Social Competence</div> <div>Autonomy</div> <p>Students can gain knowledge of the subject area from given sources and transform it to new questions. Furthermore, they can define targets for new application or research-oriented duties in for risk management and sustainability concepts accordance with the potential social, economic and cultural impact.</p>			
Workload in Hours				
Credit points				
Course achievement				
Examination				
Examination duration and scale	Elaboration and presentation (45 minutes in groups)			
Assignment for the Following Curricula	Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Water and Environmental Engineering: Core Qualification: Compulsory			

Course L1145: Safety, Reliability and Risk Assessment	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski
Language	DE
Cycle	WiSe
Content	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated: <ul style="list-style-type: none">basics in safety and reliability of technical facilitiessafety and reliability analysis methodsrisk assessmentpractical examples and excursionsdiscussions and presentations
Literature	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/sicherheit_und_zuverlaessigkeit.pdf

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0319: Environment and Sustainability	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	<p>This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list show examples.</p> <p>Production and Usage of Bio-char Energy production with algae Environmental product design Clean Development mechanism (CDM) Democracy and Energy New Concepts for a sustainable Energy Supply</p> <p>Recycling of Wind Turbines Alternative Mobility</p> <p>Disposal of Nuclear Wastes Waste2Energy Offshore Wind energy</p>
Literature	Wird in der Veranstaltung bekannt gegeben.

Module M1024: Methods of Integrated Product Development			
Courses			
Title	Typ	Hrs/wk	CP
Integrated Product Development II (L1254)	Lecture	3	3
Integrated Product Development II (L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge of Integrated product development and applying CAE systems		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	After passing the module students are able to: <ul style="list-style-type: none"> • explain technical terms of design methodology, • describe essential elements of construction management, • describe current problems and the current state of research of integrated product development. 		
<i>Skills</i>	After passing the module students are able to: <ul style="list-style-type: none"> • select and apply proper construction methods for non-standardized solutions of problems as well as adapt new boundary conditions, • solve product development problems with the assistance of a workshop based approach, • choose and execute appropriate moderation techniques. 		
Personal Competence			
<i>Social Competence</i>	After passing the module students are able to: <ul style="list-style-type: none"> • prepare and lead team meetings and moderation processes, • work in teams on complex tasks, • represent problems and solutions and advance ideas. 		
<i>Autonomy</i>	After passing the module students are able to: <ul style="list-style-type: none"> • give a structured feedback and accept a critical feedback, • implement the accepted feedback autonomous. 		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Course achievement	None		
Examination	Oral exam		
Examination duration and scale	30 Minuten		
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L1254: Integrated Product Development II	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	<p>Lecture</p> <p>The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.</p> <p>Topics of the course include in particular:</p> <ul style="list-style-type: none"> • Methods of product development, • Presentation techniques, • Industrial Design, • Design for variety • Modularization methods, • Design catalogs, • Adapted QFD matrix, • Systematic material selection, • Assembly oriented design, <p>Construction management</p> <ul style="list-style-type: none"> • CE mark, declaration of conformity including risk assessment, • Patents, patent rights, patent monitoring • Project management (cost, time, quality) and escalation principles, • Development management for mechatronics, • Technical Supply Chain Management. <p>Exercise (PBL)</p> <p>In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.</p> <p>Students learn an independently moderated and workshop based approach through industry related practice examples to solve complex and currently existing issues in product development. They will learn the ability to apply important methods of product development and design management autonomous and acquire further expertise in the field of integrated product development. Besides personal skills, such as teamwork, guiding discussions and representing work results will be acquired through the workshop based structure of the event under its own planning and management.</p>
Literature	<ul style="list-style-type: none"> • Andreassen, M.M., Design for Assembly, Berlin, Springer 1985. • Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. • Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. • Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007. • Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006. • Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000. • Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York, Springer 2013.

Course L1255: Integrated Product Development II	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1155: Aircraft Cabin Systems				
Courses				
Title	Typ		Hrs/wk	CP
Aircraft Cabin Systems (L1545)	Lecture		3	4
Aircraft Cabin Systems (L1546)	Recitation Section (large)		1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • describe cabin operations, equipment in the cabin and cabin Systems • explain the functional and non-functional requirements for cabin Systems • elucidate the necessity of cabin operating systems and emergency Systems • assess the challenges human factors integration in a cabin environment Students are able to: <ul style="list-style-type: none"> • design a cabin layout for a given business model of an Airline • design cabin systems for safe operations • design emergency systems for safe man-machine interaction • solve comfort needs and entertainment requirements in the cabin Students are able to: <ul style="list-style-type: none"> • understand existing system solutions and discuss their ideas with experts Students are able to: <ul style="list-style-type: none"> • Reflect the contents of lectures and expert presentations self-dependent 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes			
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L1545: Aircraft Cabin Systems	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge about aircraft cabin systems and cabin operations. A basic understanding of technological and systems engineering effort to maintain an artificial but comfortable and safe travel and working environment at cruising altitude is to be achieved.</p> <p>The course provides a comprehensive overview of current technology and cabin systems in modern passenger aircraft. The Fulfillment of requirements for the cabin as the central system of work are covered on the basis of the topics comfort, ergonomics, human factors, operational processes, maintenance and energy supply:</p> <ul style="list-style-type: none"> • Materials used in the cabin • Ergonomics and human factors • Cabin interior and non-electrical systems • Cabin electrical systems and lights • Cabin electronics, communication-, information- and IFE-systems • Cabin and passenger process chains • RFID Aircraft Parts Marking • Energy sources and energy conversion
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, C.-C., Wolf, K., Horst, P. (Hrsg.): Handbuch der Luftfahrzeugtechnik. Carl Hanser Verlag, 2014 - Moir, I., Seabridge, A.: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Wiley 2008 - Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGraw-Hill, 2003 - Kompendium der Flugmedizin. Verbesserte und ergänzte Neuauflage, Nachdruck April 2006. Fürstenfeldbruck, 2006 - Campbell, F.C.: Manufacturing Technology for Aerospace Structural Materials. Elsevier Ltd., 2006

Course L1546: Aircraft Cabin Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1025: Fluidics				
Courses				
Title	Typ		Hrs/wk	CP
Fluidics (L1256)	Lecture		2	3
Fluidics (L1371)	Project/problem-based Learning		1	2
Fluidics (L1257)	Recitation Section (large)		1	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	Good knowledge of mechanics (statics, elastostatics, hydrostatics, kinematics and kinetics), fluid mechanics, and engineering design			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> After passing the module students are able to</p> <ul style="list-style-type: none"> explain structures and functionalities of hydrostatic, pneumatic, and hydrodynamic components, explain the interaction of hydraulic components in hydraulic systems, explain open and closed loop control of hydraulic systems, describe functioning and applications of hydrodynamic torque converters, brakes and clutches as well as centrifugal pumps and aggregates in plant technology <p><i>Skills</i> After passing the module students are able to</p> <ul style="list-style-type: none"> analyse and assess hydraulic and pneumatic components and systems, design and dimension hydraulic systems for mechanical applications, perform numerical simulations of hydraulic systems based on abstract problem definitions, select and adapt pump characteristic curves for hydraulic systems dimension hydrodynamic torque converters and brakes for mechanical aggregates. <p>Personal Competence</p> <p><i>Social Competence</i> After passing the module students are able to</p> <ul style="list-style-type: none"> discuss and present functional context in groups, organise teamwork autonomously. <p><i>Autonomy</i> After passing the module students are able to</p> <ul style="list-style-type: none"> obtain necessary knowledge for the simulation. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	None	Attestation	Simulation hydrostatischer Systeme
Examination	Written exam			
Examination duration and scale	90			
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1256: Fluidics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	<p>Lecture</p> <p>Hydrostatics</p> <ul style="list-style-type: none"> • physical fundamentals • hydraulic fluids • hydrostatic machines • valves • components • hydrostatic transmissions • examples from industry <p>Pneumatics</p> <ul style="list-style-type: none"> • generation of compressed air • pneumatic motors • Examples of use <p>Hydrodynamics</p> <ul style="list-style-type: none"> • physical fundamentals • hydraulic continuous-flow machines • hydrodynamic transmissions • interoperation of motor and transmission <p>Exercise</p> <p>Hydrostatics</p> <ul style="list-style-type: none"> • reading and design of hydraulic diagrams • dimensioning of hydrostatic traction and working drives • performance calculation <p>Hydrodynamics</p> <ul style="list-style-type: none"> • calculation / dimensioning of hydrodynamic torque converters • calculation / dimensioning of centrifugal pumps • creating and reading of characteristic curves of pumps and systems <p>Field trip</p> <ul style="list-style-type: none"> • field trip to a regional company from the hydraulic industry. <p>Exercise</p> <p>Numerical simulation of hydrostatic systems</p> <ul style="list-style-type: none"> • getting to know a numerical simulation environment for hydraulic systems • transformation of a task into a simulation model • simulation of common components • variation of simulation parameters • using simulations for system dimensioning and optimisation • (partly) self-organised teamwork
Literature	<p>Bücher</p> <ul style="list-style-type: none"> • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011 • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006 • Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006 • Beitz, W., Grote, K.-H.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage <p>Skript zur Vorlesung</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1371: Fluidics	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1257: Fluidics	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1342: Polymers			
Courses			
Title	Typ	Hrs/wk	CP
Structure and Properties of Polymers (L0389)	Lecture	2	3
Processing and design with polymers (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich		
Admission Requirements	None		
Recommended Previous Knowledge	Basics: chemistry / physics / material science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	Students can use the knowledge of plastics and define the necessary testing and analysis. They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environmental protection).		
<i>Skills</i>	Students are capable of - using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. - selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.		
Personal Competence <i>Social Competence</i>	Students can - arrive at funded work results in heterogenius groups and document them. - provide appropriate feedback and handle feedback on their own performance constructively.		
<i>Autonomy</i>	Students are able to - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 min		
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		

Course L0389: Structure and Properties of Polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> - Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weight distribution - Morphology amorph, crystalline, blends - Properties Elasticity, plasticity, viscoelasticity - Thermal properties - Electrical properties - Theoretical modelling - Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing and design with polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich
Language	DE/EN
Cycle	WiSe
Content	<p>Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining</p> <p>Designing with Polymers: Materials Selection; Structural Design; Dimensioning</p>
Literature	<p>Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag</p> <p>Crawford: Plastics engineering, Pergamon Press</p> <p>Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag</p> <p>Konstruieren mit Kunststoffen, Gunter Erhard, Hanser Verlag</p>

Module M1170: Phenomena and Methods in Materials Science			
Courses			
Title	Typ	Hrs/wk	CP
Experimental Methods for the Characterization of Materials (L1580)	Lecture	2	3
Phase equilibria and transformations (L1579)	Lecture	2	3
Module Responsible	Prof. Jörg Weißmüller		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Werkstoffwissenschaft I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.		
<i>Skills</i>	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.		
Personal Competence			
<i>Social Competence</i>	The students are able to present solutions to specialists and to develop ideas further.		
<i>Autonomy</i>	The students are able to ... <ul style="list-style-type: none"> • assess their own strengths and weaknesses. • gather new necessary expertise by their own. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		

Course L1580: Experimental Methods for the Characterization of Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Jürgen Markmann, Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) • Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) • Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Course L1579: Phase equilibria and transformations	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	Fundamentals of statistical physics, formal structure of phenomenological thermodynamics, simple atomistic models and free-energy functions of solid solutions and compounds. Corrections due to nonlocal interaction (elasticity, gradient terms). Phase equilibria and alloy phase diagrams as consequence thereof. Simple atomistic considerations for interaction energies in metallic solid solutions. Diffusion in real systems. Kinetics of phase transformations for real-life boundary conditions. Partitioning, stability and morphology at solidification fronts. Order of phase transformations; glass transition. Phase transitions in nano- and microscale systems.
Literature	<p>D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage</p> <p>Peter Haasen, „Physikalische Metallkunde“ , Springer 1994</p> <p>Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage.</p> <p>Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996</p> <p>H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.</p>

Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)			
Courses			
Title	Typ	Hrs/wk	CP
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	See selected module according to FSPO		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	see selected module according to FSPO		
<i>Knowledge</i>			
<i>Skills</i>			
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>	see selected module according to FSPO		
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Specialization Materials

Graduates of the discipline materials are able to work in the development, production and application of materials based on a natural scientific education. The material-oriented graduates can identify new fields of application and make the application-specific selection of the material under consideration of function, costs and quality.

Module M0763: Aircraft Energy Systems (FS1)

Courses

Title	Typ	Hrs/wk	CP
Aircraft Systems I (L0735)	Lecture	3	4
Aircraft Systems I (L0739)	Recitation Section (large)	2	2

Module Responsible	Prof. Frank Thielecke
---------------------------	-----------------------

Admission Requirements	None
-------------------------------	------

Recommended Previous Knowledge	<p>Basic knowledge in:</p> <ul style="list-style-type: none"> Mathematics Mechanics Thermodynamics Electrical Engineering Hydraulics Control Systems
---------------------------------------	--

Educational Objectives	After taking part successfully, students have reached the following learning results
-------------------------------	--

Professional Competence <i>Knowledge</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Describe essential components and design points of hydraulic, electrical and high-lift systems Give an overview of the functionality of air conditioning systems Explain the need for high-lift systems such as its functionality and effects Assess the challenge during the design of supply systems of an aircraft
<i>Skills</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Design hydraulic and electric supply systems of aircrafts Design high-lift systems of aircrafts Analyze the thermodynamic behaviour of air conditioning systems
Personal Competence <i>Social Competence</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Perform system design in groups and present and discuss results
<i>Autonomy</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Reflect the contents of lectures autonomously

Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
--------------------------	--

Credit points	6
----------------------	---

Course achievement	None
---------------------------	------

Examination	Written exam
--------------------	--------------

Examination duration and scale	165 Minutes
---------------------------------------	-------------

Assignment for the Following Curricula	<p>Energy Systems: Specialisation Energy Systems: Elective Compulsory</p> <p>Aircraft Systems Engineering: Core Qualification: Compulsory</p> <p>International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory</p>
---	---

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0735: Aircraft Systems I	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> Hydraulic Energy Systems (Fluids; pressure loss in valves and pipes; components of hydraulic systems like pumps, valves, etc.; pressure/flow characteristics; actuators; tanks; power and heat balances; emergency power) Electric Energy Systems (Generators; constant-speed-drives; DC and AC converters; electrical power distribution; bus systems; monitoring; load analysis) High Lift Systems (Principles; investigation of loads and system actuation power; principles and sizing of actuation and positioning systems; safety requirements and devices) Environmental Control Systems (Thermodynamic analysis; expansion and compression cooling systems; control strategies; cabin pressure control systems)
Literature	<ul style="list-style-type: none"> Moir, Seabridge: Aircraft Systems Green: Aircraft Hydraulic Systems Torenbek: Synthesis of Subsonic Airplane Design SAE1991: ARP; Air Conditioning Systems for Subsonic Airplanes

Course L0739: Aircraft Systems I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1141: Selected Topics of Product Development, Materials Science and Production (Alternative A: 12 LP)

Courses

Title	Typ	Hrs/wk	CP
Applied Automation (L1592)	Project-/problem-based Learning	3	3
Ergonomics (L0653)	Lecture	2	3
Elements of Integrated Production Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
Innovation and Product Management (L2168)	Seminar	2	3
Lightweight Design Practical Course (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Processes of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Technology (L0664)	Lecture	2	3
Six Sigma (L1130)	Lecture	2	3
Structural Mechanics of Fibre Reinforced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Ceramics Technology (L0379)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics (L0176)	Lecture	2	2
Reliability in Engineering Dynamics (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L0749)	Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of product development, materials and production Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> - <i>Autonomy</i> <ul style="list-style-type: none"> Students are able to develop their knowledge and skills by autonomous election of courses. 			
Workload in Hours	Depends on choice of courses		
Credit points	12		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1592: Applied Automation	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> -Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy
Literature	<p>John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005</p> <p>Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010</p> <p>K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wiley & Sons, Inc., 1992</p>

Course L0653: Ergonomics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Armin Bossemeyer
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0927: Elements of Integrated Production Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	not available
Literature	<p>Harris, R.; Harris, C.; Wilson, E.: Making Materials Flow, Lean Enterprise Institute, Cambridge, 2003.</p> <p>Ohno, T.: Das Toyota-Produktionssystem, Campus-Verlag, Frankfurt et al, 1993.</p> <p>Rother, M.: Die Kata des Weltmarktführers. Toyotas Erfolgsmethoden, Campus-Verlag, Frankfurt et al, 2009.</p> <p>Rother, M.; Shook, J.: Sehen lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen, Lean Management Institut, Aachen, 2006.</p> <p>Rother, M.; Harris, R.: Creating Continuous Flow, Lean Enterprise Institute, Brookline, 2001.</p> <p>Shingo, S.: A Revolution in Manufacturing. The SMED System, Productivity Press, 2006.</p> <p>Womack, J. P. et al: Die zweite Revolution in der Autoindustrie, Frankfurt/New York, Campus Verlag, 1992.</p>

Course L1512: Development Management for Mechatronics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Johannes Nicolas Gebhardt, Dr. Daniel Steffen
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Processes and methods of product development - from idea to market launch <ul style="list-style-type: none"> identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development <ul style="list-style-type: none"> Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	<ul style="list-style-type: none"> Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

Course L0310: Fatigue & Damage Tolerance	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Martin Flamm
Language	EN
Cycle	WiSe
Content	Design principles, fatigue strength, crack initiation and crack growth, damage calculation, counting methods, methods to improve fatigue strength, environmental influences
Literature	Jaap Schijve, Fatigue of Structures and Materials. Kluwer Academic Publisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

Course L2012: Industry 4.0 for engineers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	120 min
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2168: Innovation and Product Management	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christoph Fuchs
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1258: Lightweight Design Practical Course	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	<p>Development of a sandwich structure made of fibre reinforced plastics</p> <ul style="list-style-type: none"> • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion“, Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation“, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0950: Mechanisms, Systems and Processes of Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	<p>Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies</p> <ul style="list-style-type: none"> • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	<ul style="list-style-type: none"> • E. Macherauch: Praktikum in Werkstoffkunde, Vieweg • G. E. Dieter: Mechanical Metallurgy, McGraw-Hill • R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg • R. Bürgel: Werkstoffe sicher beurteilen und richtig einsetzen, Vieweg

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0724: Microsystems Technology	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction (historical view, scientific and economic relevance, scaling laws) • Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) • Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) • Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) • Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) • Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) • Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) • Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) • Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics) • MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration) • Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship) • System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	<p>M. Madou: Fundamentals of Microfabrication, CRC Press, 2002</p> <p>N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009</p> <p>T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010</p> <p>G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0928: Productivity Management	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Principles of productivity management • Shop floor management and standardisation • Takt analysis and design of manual operations • Maintenance Principles • Total Productive Maintenance (TPM) • Optimisation of set-up operations • Analysis of interlinked production systems
Literature	<p>Bokranz, R.; Landau, K.: Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.</p> <p>Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.</p> <p>Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.</p> <p>Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985</p>

Course L0931: Productivity Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0664: Feedback Control in Medical Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	<p>Always viewed from the engineer's point of view, the lecture is structured as follows:</p> <ul style="list-style-type: none"> • Introduction to the topic • Fundamentals of physiological modelling • Introduction to Breathing and Ventilation • Physiology and Pathology in Cardiology • Introduction to the Regulation of Blood Glucose • kidney function and renal replacement therapy • Representation of the control technology on the concrete ventilator • Excursion to a medical technology company <p>Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.</p>
Literature	<ul style="list-style-type: none"> • Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. • Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. • Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Course L1130: Six Sigma	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Claus Emmelmann
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction and structuring • Basic terms of quality management • Measuring and inspection equipment • Tools of quality management: FMEA, QFD, FTA, etc. • Quality management methodology Six Sigma, DMAIC
Literature	<p>Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008</p> <p>Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996</p> <p>Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008</p>

Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	<p>Classical laminate theory</p> <p>Rules of mixture</p> <p>Failure mechanisms and criteria of composites</p> <p>Boundary value problems of isotropic and anisotropic shells</p> <p>Stability of composite structures</p> <p>Optimization of laminated composites</p> <p>Modelling composites in FEM</p> <p>Numerical multiscale analysis of textile composites</p> <p>Progressive failure analysis</p>
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, aktuelle Auflage. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, , aktuelle Auflage. • Reddy, J.N., „Mechanics of Composite Laminated Plates and Shells“, CRC Publishing, Boca Raton et al., current edition. • Jones, R.M., „Mechanics of Composite Materials“, Scripta Book Co., Washington, current edition. • Timoshenko, S.P., Gere, J.M., „Theory of elastic stability“, McGraw-Hill Book Company, Inc., New York, current edition. • Turvey, G.J., Marshall, I.H., „Buckling and postbuckling of composite plates“, Chapman and Hall, London, current edition. • Herakovich, C.T., „Mechanics of fibrous composites“, John Wiley and Sons, Inc., New York, current edition. • Mittelstedt, C., Becker, W., „Strukturmechanik ebener Laminate“, aktuelle Auflage.

Course L1820: System Simulation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	<p>Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica.</p> <ul style="list-style-type: none"> • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	<p>[1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7</p> <p>[2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014.</p> <p>[3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</p> <p>[4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</p> <p>[5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1821: System Simulation	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Basics with analysis, concept, proposal drawings and sketches Samples from practice of technical industrial design Product concept with new ideas and package ID proposal with structural concept and external product ergonomics Visualisation and presentation of the overall concept Realization as individual case studies
Literature	<p>Literatur über technisches Produktdesign</p> <p>Technisches Rendering und Präsentation</p> <p>Zeichnen und perspektivisches Entwerfen</p> <p>Literaturhinweise</p> <p>What is Product Design ?</p> <p>Laura Slack</p> <p>RotoVision Schweiz 2006</p> <p>Product Design Now</p> <p>Design and Scetches</p> <p>CollinsDesign and maomao publications Spanien 2006</p> <p>Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects,</p> <p>Watson, Gupta Publications, a division of Billboard Publications Inc., New York 1983</p> <p>Creative Techniques</p> <p>DRAWING</p> <p>Barons Educational Series</p> <p>ISBN-13: 978-0-7641-6182-7</p> <p>Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators</p> <p>Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985</p> <p>AIRWORLD</p> <p>Design und Architektur für die Flugreise</p> <p>Vitra Design Stiftung Weil am Rhein 2004</p>

	<p>Airline Design</p> <p>Perter Deslius Jacek Slaski te Neues 2005</p> <p>Technik und Sicherheit von Passagierflugzeugen</p> <p>Frank Littek</p> <p>Motorbuch Verlag 2003</p> <p>Jetliner Cabins</p> <p>Jennifer Coutts Clay</p> <p>Cs books England 2006</p> <p>BOEING Widebodies</p> <p>Michael Haenggi motorbooks international USA 2003</p> <p>form - Zeitschrift für Gestaltung, Verlag form GmbH,</p> <p>Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim</p> <p>(erscheint vierteljährlich, Verlag form GmbH)</p> <p>design report</p> <p>german magasin,</p> <p>(erscheint monatlich)</p> <p>md - möbel interior design, Konradin-Verlag</p> <p>Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen</p> <p>(erscheint monatlich)</p> <p>CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,</p> <p>Kitashinjuku, Shinjuku-ku, Tokio 160, Japan</p> <p>(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,</p> <p>Auto & Design,</p> <p>Corso Frabcia 161, 10139 Torino, Italia</p> <p>(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei</p> <p>Monate , erhältlich am HBF Hamburg</p> <p>AERO International,</p> <p>Magazin für Zivilluftfahrt</p> <p>(erscheint monatlich)</p> <p>Aircraft interior international</p> <p>Engl. magasin for Aircraft cabin interior</p> <p>(erscheint 2 monatlich)</p> <p>aerotec</p> <p>Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie</p>
--	---

Course L0379: Ceramics Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Rolf Janßen
Language	DE/EN
Cycle	WiSe
Content	<p>Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metallurgical techniques and sintering (solid state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed. Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.</p> <p>Content:</p> <ol style="list-style-type: none"> 1. Introduction 2. Raw materials 3. Powder fabrication 4. Powder processing 5. Shape-forming processes 6. Densification, sintering 7. Glass and Cement technology 8. Ceramic-metal joining techniques <p>Inhalt:</p>
Literature	<p>W.D. Kingery, „Introduction to Ceramics“, John Wiley & Sons, New York, 1975</p> <p>ASM Engineering Materials Handbook Vol.4 „Ceramics and Glasses“, 1991</p> <p>D.W. Richerson, „Modern Ceramic Engineering“, Marcel Dekker, New York, 1992</p> <p>Skript zur Vorlesung</p>

Course L0949: Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	<p>Application and analysis of basic mechanical as well as non-destructive testing of materials</p> <ul style="list-style-type: none"> • Determination elastic constants • Tensile test • Fatigue test (testing with constant stress, strain, or plastic strain amplitude, low and high cycle fatigue, mean stress effect) • Crack growth upon static loading (stress intensity factor, fracture toughness) • Creep test • Hardness test • Charpy impact test • Non destructive testing
Literature	<p>E. Macherauch: Praktikum in Werkstoffkunde, Vieweg</p> <p>G. E. Dieter: Mechanical Metallurgy, McGraw-Hill</p>

Course L0176: Reliability in Engineering Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min.
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	<p>Method for calculation and testing of reliability of dynamic machine systems</p> <ul style="list-style-type: none"> • Modeling • System identification • Simulation • Processing of measurement data • Damage accumulation • Test planning and execution
Literature	<p>Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4</p> <p>Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737</p> <p>Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.</p> <p>VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412</p>

Course L1303: Reliability in Engineering Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0749: Reliability of Aircraft Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wiecek
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Functions of reliability and safety (regulations, certification requirements) • Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment) • Reliability analysis of electrical and mechanical systems
Literature	<ul style="list-style-type: none"> • CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1209: Selected Topics of Product Development, Materials Science and Production (Alternative B: 6 LP)			
Courses			
Title	Typ	Hrs/wk	CP
Applied Automation (L1592)	Project-/problem-based Learning	3	3
Ergonomics (L0653)	Lecture	2	3
Elements of Integrated Production Systems (L0927)	Project-/problem-based Learning	2	3
Development Management for Mechatronics (L1512)	Lecture	2	3
Fatigue & Damage Tolerance (L0310)	Lecture	2	3
Industry 4.0 for engineers (L2012)	Lecture	2	3
Innovation and Product Management (L2168)	Seminar	2	3
Lightweight Design Practical Course (L1258)	Project-/problem-based Learning	3	3
Mechanisms, Systems and Processes of Materials Testing (L0950)	Lecture	2	2
Microsystems Technology (L0724)	Lecture	2	4
Productivity Management (L0928)	Project-/problem-based Learning	2	2
Productivity Management (L0931)	Recitation Section (small)	1	1
Feedback Control in Medical Technology (L0664)	Lecture	2	3
Six Sigma (L1130)	Lecture	2	3
Structural Mechanics of Fibre Reinforced Composites (L1514)	Lecture	2	3
System Simulation (L1820)	Lecture	2	2
System Simulation (L1821)	Recitation Section (large)	1	2
Technical Design (L1513)	Lecture	2	3
Ceramics Technology (L0379)	Lecture	2	3
Materials Testing (L0949)	Lecture	2	2
Reliability in Engineering Dynamics (L0176)	Lecture	2	2
Reliability in Engineering Dynamics (L1303)	Recitation Section (small)	1	2
Reliability of Aircraft Systems (L0749)	Lecture	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	None		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students are able to express their extended knowledge and discuss the connection of different special fields or application areas of product development, materials and production Students are qualified to connect different special fields with each other <i>Skills</i> <ul style="list-style-type: none"> Students can apply specialized solution strategies and new scientific methods in selected areas Students are able to transfer learned skills to new and unknown problems and can develop own solution approaches Personal Competence <i>Social Competence</i> - <i>Autonomy</i> <ul style="list-style-type: none"> Students are able to develop their knowledge and skills by autonomous election of courses. 			
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1592: Applied Automation	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> -Project Based Learning -Robot Operating System -Robot structure and description -Motion description -Calibration -Accuracy
Literature	<p>John J. Craig Introduction to Robotics - Mechanics and Control ISBN: 0131236296 Pearson Education, Inc., 2005</p> <p>Stefan Hesse Grundlagen der Handhabungstechnik ISBN: 3446418725 München Hanser, 2010</p> <p>K. Thulasiraman and M. N. S. Swamy Graphs: Theory and Algorithms ISBN: 9781118033104 %CITAVIPICKER£9781118033104£Titel anhand dieser ISBN in Citavi-Projekt übernehmen£% John Wiley & Sons, Inc., 1992</p>

Course L0653: Ergonomics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Armin Bossemeyer
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0927: Elements of Integrated Production Systems	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	not available
Literature	<p>Harris, R.; Harris, C.; Wilson, E.: Making Materials Flow, Lean Enterprise Institute, Cambridge, 2003.</p> <p>Ohno, T.: Das Toyota-Produktionssystem, Campus-Verlag, Frankfurt et al, 1993.</p> <p>Rother, M.: Die Kata des Weltmarktführers. Toyotas Erfolgsmethoden, Campus-Verlag, Frankfurt et al, 2009.</p> <p>Rother, M.; Shook, J.: Sehen lernen: Mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen, Lean Management Institut, Aachen, 2006.</p> <p>Rother, M.; Harris, R.: Creating Continuous Flow, Lean Enterprise Institute, Brookline, 2001.</p> <p>Shingo, S.: A Revolution in Manufacturing. The SMED System, Productivity Press, 2006.</p> <p>Womack, J. P. et al: Die zweite Revolution in der Autoindustrie, Frankfurt/New York, Campus Verlag, 1992.</p>

Course L1512: Development Management for Mechatronics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 Minuten
Lecturer	Dr. Johannes Nicolas Gebhardt, Dr. Daniel Steffen
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Processes and methods of product development - from idea to market launch <ul style="list-style-type: none"> identification of market and technology potentials development of a common product architecture Synchronized product development across all engineering disciplines product validation incl. customer view Steering and optimization of product development <ul style="list-style-type: none"> Design of processes for product development IT systems for product development Establishment of management standards Typical types of organization
Literature	<ul style="list-style-type: none"> Bender: Embedded Systems - qualitätsorientierte Entwicklung Ehrlenspiel: Integrierte Produktentwicklung: Denkabläufe, Methodeneinsatz, Zusammenarbeit Gausemeier/Ebbesmeyer/Kallmeyer: Produktinnovation - Strategische Planung und Entwicklung der Produkte von morgen Haberfellner/de Weck/Fricke/Vössner: Systems Engineering: Grundlagen und Anwendung Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden Pahl/Beitz: Konstruktionslehre: Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung VDI-Richtlinie 2206: Entwicklungsmethodik für mechatronische Systeme

Course L0310: Fatigue & Damage Tolerance	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	45 min
Lecturer	Dr. Martin Flamm
Language	EN
Cycle	WiSe
Content	Design principles, fatigue strength, crack initiation and crack growth, damage calculation, counting methods, methods to improve fatigue strength, environmental influences
Literature	Jaap Schijve, Fatigue of Structures and Materials. Kluwer Academic Publisher, Dordrecht, 2001 E. Haibach. Betriebsfestigkeit Verfahren und Daten zur Bauteilberechnung. VDI-Verlag, Düsseldorf, 1989

Course L2012: Industry 4.0 for engineers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	120 min
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2168: Innovation and Product Management	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Christoph Fuchs
Language	DE
Cycle	WiSe/SoSe
Content	
Literature	

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1258: Lightweight Design Practical Course	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Dieter Krause
Language	DE/EN
Cycle	SoSe
Content	<p>Development of a sandwich structure made of fibre reinforced plastics</p> <ul style="list-style-type: none"> • getting familiar with fibre reinforced plastics as well as lightweight design • Design of a sandwich structure made of fibre reinforced plastics using finite element analysis (FEA) • Determination of material properties based on sample tests • manufacturing of the structure in the composite lab • Testing of the developed structure • Concept presentation • Self-organised teamwork
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, 2005. • Puck, A., „Festigkeitsanalyse von Faser-Matrix-Laminaten“, Hanser, München, Wien, 1996. • R&G, „Handbuch Faserverbundwerkstoffe“, Waldenbuch, 2009. • VDI 2014 „Entwicklung von Bauteilen aus Faser-Kunststoff-Verbund“ • Ehrenstein, G. W., „Faserverbundkunststoffe“, Hanser, München, 2006. • Klein, B., „Leichtbau-Konstruktion“, Vieweg & Sohn, Braunschweig, 1989. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, 1986. • Wiedemann, J., „Leichtbau Band 2: Konstruktion“, Springer, Berlin, Heidelberg, 1986. • Backmann, B.F., „Composite Structures, Design, Safety and Innovation“, Oxford (UK), Elsevier, 2005. • Krause, D., „Leichtbau“, In: Handbuch Konstruktion, Hrsg.: Rieg, F., Steinhilper, R., München, Carl Hanser Verlag, 2012. • Schulte, K., Fiedler, B., „Structure and Properties of Composite Materials“, Hamburg, TUHH - TuTech Innovation GmbH, 2005.

Course L0950: Mechanisms, Systems and Processes of Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	SoSe
Content	<p>Application, analysis and discussion of basic and advanced testing methods to ensure correct selection of applicable testing procedure for investigation of part/materials deficiencies</p> <ul style="list-style-type: none"> • Stress-strain relationships • Strain gauge application • Visko elastic behavior • Tensile test (strain hardening, necking, strain rate) • Compression test, bending test, torsion test • Crack growth upon static loading (J-Integral) • Crack growth upon cyclic loading (micro- und macro cracks) • Effect of notches • Creep testing (physical creep test, influence of stress and temperature, Larson Miller parameter) • Wear testing • Non destructive testing application for overhaul of jet engines
Literature	<ul style="list-style-type: none"> • E. Macherauch: Praktikum in Werkstoffkunde, Vieweg • G. E. Dieter: Mechanical Metallurgy, McGraw-Hill • R. Bürgel: Lehr- und Übungsbuch Festigkeitslehre, Vieweg • R. Bürgel: Werkstoffe sicher beurteilen und richtig einsetzen, Vieweg

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0724: Microsystems Technology	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Hoc Khiem Trieu
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction (historical view, scientific and economic relevance, scaling laws) • Semiconductor Technology Basics, Lithography (wafer fabrication, photolithography, improving resolution, next-generation lithography, nano-imprinting, molecular imprinting) • Deposition Techniques (thermal oxidation, epitaxy, electroplating, PVD techniques: evaporation and sputtering; CVD techniques: APCVD, LPCVD, PECVD and LECVD; screen printing) • Etching and Bulk Micromachining (definitions, wet chemical etching, isotropic etch with HNA, electrochemical etching, anisotropic etching with KOH/TMAH: theory, corner undercutting, measures for compensation and etch-stop techniques; plasma processes, dry etching: back sputtering, plasma etching, RIE, Bosch process, cryo process, XeF2 etching) • Surface Micromachining and alternative Techniques (sacrificial etching, film stress, stiction: theory and counter measures; Origami microstructures, Epi-Poly, porous silicon, SOI, SCREAM process, LIGA, SU8, rapid prototyping) • Thermal and Radiation Sensors (temperature measurement, self-generating sensors: Seebeck effect and thermopile; modulating sensors: thermo resistor, Pt-100, spreading resistance sensor, pn junction, NTC and PTC; thermal anemometer, mass flow sensor, photometry, radiometry, IR sensor: thermopile and bolometer) • Mechanical Sensors (strain based and stress based principle, capacitive readout, piezoresistivity, pressure sensor: piezoresistive, capacitive and fabrication process; accelerometer: piezoresistive, piezoelectric and capacitive; angular rate sensor: operating principle and fabrication process) • Magnetic Sensors (galvanomagnetic sensors: spinning current Hall sensor and magneto-transistor; magnetoresistive sensors: magneto resistance, AMR and GMR, fluxgate magnetometer) • Chemical and Bio Sensors (thermal gas sensors: pellistor and thermal conductivity sensor; metal oxide semiconductor gas sensor, organic semiconductor gas sensor, Lambda probe, MOSFET gas sensor, pH-FET, SAW sensor, principle of biosensor, Clark electrode, enzyme electrode, DNA chip) • Micro Actuators, Microfluidics and TAS (drives: thermal, electrostatic, piezo electric and electromagnetic; light modulators, DMD, adaptive optics, microscanner, microvalves: passive and active, micropumps, valveless micropump, electrokinetic micropumps, micromixer, filter, inkjet printhead, microdispenser, microfluidic switching elements, microreactor, lab-on-a-chip, microanalytics) • MEMS in medical Engineering (wireless energy and data transmission, smart pill, implantable drug delivery system, stimulators: microelectrodes, cochlear and retinal implant; implantable pressure sensors, intelligent osteosynthesis, implant for spinal cord regeneration) • Design, Simulation, Test (development and design flows, bottom-up approach, top-down approach, testability, modelling: multiphysics, FEM and equivalent circuit simulation; reliability test, physics-of-failure, Arrhenius equation, bath-tub relationship) • System Integration (monolithic and hybrid integration, assembly and packaging, dicing, electrical contact: wire bonding, TAB and flip chip bonding; packages, chip-on-board, wafer-level-package, 3D integration, wafer bonding: anodic bonding and silicon fusion bonding; micro electroplating, 3D-MID)
Literature	<p>M. Madou: Fundamentals of Microfabrication, CRC Press, 2002</p> <p>N. Schwesinger: Lehrbuch Mikrosystemtechnik, Oldenbourg Verlag, 2009</p> <p>T. M. Adams, R. A. Layton: Introductory MEMS, Springer, 2010</p> <p>G. Gerlach; W. Dötzel: Introduction to microsystem technology, Wiley, 2008</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0928: Productivity Management	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Principles of productivity management • Shop floor management and standardisation • Takt analysis and design of manual operations • Maintenance Principles • Total Productive Maintenance (TPM) • Optimisation of set-up operations • Analysis of interlinked production systems
Literature	<p>Bokranz, R.; Landau, K.: Produktivitätsmanagement von Arbeitssystemen. Schäffer-Poeschel, Stuttgart, 2006.</p> <p>Takeda, H.: Das synchrone Produktionssystem: Just-in-Time für das ganze Unternehmen. 5. Aufl., mi-Wirtschaftsbuch, FinanzBuch Verlag, München, 2006.</p> <p>Nakajima, S.: Management der Produktionseinrichtungen (Total Productive Maintenance). Campus Verlag, New York, 1995.</p> <p>Shingo, S.: A Revolution in Manufacturing: The SMED System. Productivity, Inc., 1985</p>

Course L0931: Productivity Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0664: Feedback Control in Medical Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Johannes Kreuzer, Christian Neuhaus
Language	DE
Cycle	SoSe
Content	<p>Always viewed from the engineer's point of view, the lecture is structured as follows:</p> <ul style="list-style-type: none"> • Introduction to the topic • Fundamentals of physiological modelling • Introduction to Breathing and Ventilation • Physiology and Pathology in Cardiology • Introduction to the Regulation of Blood Glucose • kidney function and renal replacement therapy • Representation of the control technology on the concrete ventilator • Excursion to a medical technology company <p>Techniques of modeling, simulation and controller development are discussed. In the models, simple equivalent block diagrams for physiological processes are derived and explained how sensors, controllers and actuators are operated. MATLAB and SIMULINK are used as development tools.</p>
Literature	<ul style="list-style-type: none"> • Leonhardt, S., & Walter, M. (2016). Medizintechnische Systeme. Berlin, Heidelberg: Springer Vieweg. • Werner, J. (2005). Kooperative und autonome Systeme der Medizintechnik. München: Oldenbourg. • Oczenski, W. (2017). Atmen : Atemhilfen ; Atemphysiologie und Beatmungstechnik: Georg Thieme Verlag KG.

Course L1130: Six Sigma	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Claus Emmelmann
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Introduction and structuring • Basic terms of quality management • Measuring and inspection equipment • Tools of quality management: FMEA, QFD, FTA, etc. • Quality management methodology Six Sigma, DMAIC
Literature	<p>Pfeifer, T.: Qualitätsmanagement : Strategien, Methoden, Techniken, 4. Aufl., München 2008</p> <p>Pfeifer, T.: Praxishandbuch Qualitätsmanagement, München 1996</p> <p>Geiger, W., Kotte, W.: Handbuch Qualität : Grundlagen und Elemente des Qualitätsmanagements: Systeme, Perspektiven, 5. Aufl., Wiesbaden 2008</p>

Course L1514: Structural Mechanics of Fibre Reinforced Composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Prof. Benedikt Kriegesmann
Language	EN
Cycle	WiSe
Content	<p>Classical laminate theory</p> <p>Rules of mixture</p> <p>Failure mechanisms and criteria of composites</p> <p>Boundary value problems of isotropic and anisotropic shells</p> <p>Stability of composite structures</p> <p>Optimization of laminated composites</p> <p>Modelling composites in FEM</p> <p>Numerical multiscale analysis of textile composites</p> <p>Progressive failure analysis</p>
Literature	<ul style="list-style-type: none"> • Schürmann, H., „Konstruieren mit Faser-Kunststoff-Verbunden“, Springer, Berlin, aktuelle Auflage. • Wiedemann, J., „Leichtbau Band 1: Elemente“, Springer, Berlin, Heidelberg, , aktuelle Auflage. • Reddy, J.N., „Mechanics of Composite Laminated Plates and Shells“, CRC Publishing, Boca Raton et al., current edition. • Jones, R.M., „Mechanics of Composite Materials“, Scripta Book Co., Washington, current edition. • Timoshenko, S.P., Gere, J.M., „Theory of elastic stability“, McGraw-Hill Book Company, Inc., New York, current edition. • Turvey, G.J., Marshall, I.H., „Buckling and postbuckling of composite plates“, Chapman and Hall, London, current edition. • Herakovich, C.T., „Mechanics of fibrous composites“, John Wiley and Sons, Inc., New York, current edition. • Mittelstedt, C., Becker, W., „Strukturmechanik ebener Lamine“, aktuelle Auflage.

Course L1820: System Simulation	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	<p>Lecture about equation-based, physical modelling using the modelling language Modelica and the free simulation tool OpenModelica.</p> <ul style="list-style-type: none"> • Instruction and modelling of physical processes • Modelling and limits of model • Time constant, stiffness, stability, step size • Terms of object orientated programming • Differential equations of simple systems • Introduction into Modelica • Introduction into simulation tool • Example:Hydraulic systems and heat transfer • Example: System with different subsystems
Literature	<p>[1] Modelica Association: "Modelica Language Specification - Version 3.4", Linköping, Sweden, 2 0 1 7</p> <p>[2] M. Tiller: "Modelica by Example", http://book.xogeny.com, 2014.</p> <p>[3] M. Otter, H. Elmqvist, et al.: "Objektorientierte Modellierung Physikalischer Systeme", at- Automatisierungstechnik (german), Teil 1 - 17, Oldenbourg Verlag, 1999 - 2000.</p> <p>[4] P. Fritzson: "Principles of Object-Oriented Modeling and Simulation with Modelica 3.3", Wiley-IEEE Press, New York, 2015.</p> <p>[5] P. Fritzson: "Introduction to Modeling and Simulation of Technical and Physical Systems with Modelica", Wiley, New York, 2011.</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1821: System Simulation	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Mündliche Prüfung
Examination duration and scale	30 min
Lecturer	Dr. Stefan Wischhusen
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1513: Technical Design	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	10-15 Entwurfszeichnungen, Skizzen und ca. 5-10 A4-Dokumentationsseiten (Themen- und Entwurfsbegründung)
Lecturer	Prof. Werner Granzeier
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> Basics with analysis, concept, proposal drawings and sketches Samples from practice of technical industrial design Product concept with new ideas and package ID proposal with structural concept and external product ergonomics Visualisation and presentation of the overall concept Realization as individual case studies
Literature	<p>Literatur über technisches Produktdesign</p> <p>Technisches Rendering und Präsentation</p> <p>Zeichnen und perspektivisches Entwerfen</p> <p>Literaturhinweise</p> <p>What is Product Design ?</p> <p>Laura Slack</p> <p>RotoVision Schweiz 2006</p> <p>Product Design Now</p> <p>Design and Scetches</p> <p>CollinsDesign and maomao publications Spanien 2006</p> <p>Ronald B. Kemnitzer, Rendering With Markers - Definitive Techniques for Designers, Illustrators and Architects,</p> <p>Watson, Gupta Publications, a division of Billboard Publications Inc., New York 1983</p> <p>Creative Techniques</p> <p>DRAWING</p> <p>Barons Educational Series</p> <p>ISBN-13: 978-0-7641-6182-7</p> <p>Joseph Ungar, Rendering In Mixed Media - Techniques for Concept Presentation for Designers and Illustrators</p> <p>Watson-Guptil Publication a division of Billboard Publications Inc., New York 1985</p> <p>AIRWORLD</p> <p>Design und Architektur für die Flugreise</p> <p>Vitra Design Stiftung Weil am Rhein 2004</p>

	<p>Airline Design</p> <p>Perter Deslius Jacek Slaski te Neues 2005</p> <p>Technik und Sicherheit von Passagierflugzeugen</p> <p>Frank Littek</p> <p>Motorbuch Verlag 2003</p> <p>Jetliner Cabins</p> <p>Jennifer Coutts Clay</p> <p>Cs books England 2006</p> <p>BOEING Widebodies</p> <p>Michael Haenggi motorbooks international USA 2003</p> <p>form - Zeitschrift für Gestaltung, Verlag form GmbH,</p> <p>Hofgut Ober-Berrbach, 6104 Seeheim-Jugenheim</p> <p>(erscheint vierteljährlich, Verlag form GmbH)</p> <p>design report</p> <p>german magasin,</p> <p>(erscheint monatlich)</p> <p>md - möbel interior design, Konradin-Verlag</p> <p>Robert Kohlhammer GmbH, 7022 Leinfelden-Echterdingen</p> <p>(erscheint monatlich)</p> <p>CAR STYLING, Car Styling Publishing Co. 4-8-16-11F,</p> <p>Kitashinjuku, Shinjuku-ku, Tokio 160, Japan</p> <p>(erscheint vierteljährlich in japanischer und englischer Sprache, in Hamburg erhältlich bei: Overseas Courier Service Deutschland GmbH,</p> <p>Auto & Design,</p> <p>Corso Frabcia 161, 10139 Torino, Italia</p> <p>(erscheint vierteljährlich in italienischer und englischer Sprache alle zwei</p> <p>Monate , erhältlich am HBF Hamburg</p> <p>AERO International,</p> <p>Magazin für Zivilluftfahrt</p> <p>(erscheint monatlich)</p> <p>Aircraft interior international</p> <p>Engl. magasin for Aircraft cabin interior</p> <p>(erscheint 2 monatlich)</p> <p>aerotec</p> <p>Technik- und Branchenmagazin für die Luft- und Raumfahrtindustrie</p>
--	---

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0379: Ceramics Technology	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Rolf Janßen
Language	DE/EN
Cycle	WiSe
Content	<p>Introduction to ceramic processing with emphasis on advanced structural ceramics. The course focus predominatly on powder-based processing, e.g. "powder-metallurgical techniques and sintering (solid state and liquid phase). Also, some aspects of glass and cement science as well as new developments in powderless forming techniques of ceramics and ceramic composites will be addressed. Examples will be discussed in order to give engineering students an understanding of technology development and specific applications of ceramic components.</p> <p>Content:</p> <ol style="list-style-type: none"> 1. Introduction 2. Raw materials 3. Powder fabrication 4. Powder processing 5. Shape-forming processes 6. Densification, sintering 7. Glass and Cement technology 8. Ceramic-metal joining techniques <p>Inhalt:</p>
Literature	<p>W.D. Kingery, „Introduction to Ceramics“, John Wiley & Sons, New York, 1975</p> <p>ASM Engineering Materials Handbook Vol.4 „Ceramics and Glasses“, 1991</p> <p>D.W. Richerson, „Modern Ceramic Engineering“, Marcel Dekker, New York, 1992</p> <p>Skript zur Vorlesung</p>

Course L0949: Materials Testing	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Dr. Jan Oke Peters
Language	DE
Cycle	WiSe
Content	<p>Application and analysis of basic mechanical as well as non-destructive testing of materials</p> <ul style="list-style-type: none"> • Determination elastic constants • Tensile test • Fatigue test (testing with constant stress, strain, or plastic strain amplitude, low and high cycle fatigue, mean stress effect) • Crack growth upon static loading (stress intensity factor, fracture toughness) • Creep test • Hardness test • Charpy impact test • Non destructive testing
Literature	<p>E. Macherauch: Praktikum in Werkstoffkunde, Vieweg</p> <p>G. E. Dieter: Mechanical Metallurgy, McGraw-Hill</p>

Course L0176: Reliability in Engineering Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 min.
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	<p>Method for calculation and testing of reliability of dynamic machine systems</p> <ul style="list-style-type: none"> • Modeling • System identification • Simulation • Processing of measurement data • Damage accumulation • Test planning and execution
Literature	<p>Bertsche, B.: Reliability in Automotive and Mechanical Engineering. Springer, 2008. ISBN: 978-3-540-33969-4</p> <p>Inman, Daniel J.: Engineering Vibration. Prentice Hall, 3rd Ed., 2007. ISBN-13: 978-0132281737</p> <p>Dresig, H., Holzweißig, F.: Maschinendynamik, Springer Verlag, 9. Auflage, 2009. ISBN 3540876936.</p> <p>VDA (Hg.): Zuverlässigkeitssicherung bei Automobilherstellern und Lieferanten. Band 3 Teil 2, 3. überarbeitete Auflage, 2004. ISSN 0943-9412</p>

Course L1303: Reliability in Engineering Dynamics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	90 min
Lecturer	Prof. Uwe Weltin
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0749: Reliability of Aircraft Systems	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	90 Minuten
Lecturer	Prof. Frank Thielecke, Dr. Andreas Vahl, Dr. Uwe Wiecek
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Functions of reliability and safety (regulations, certification requirements) • Basics methods of reliability analysis (FMEA, fault tree, functional hazard assessment) • Reliability analysis of electrical and mechanical systems
Literature	<ul style="list-style-type: none"> • CS 25.1309 • SAE ARP 4754 • SAE ARP 4761

Module M1193: Cabin Systems Engineering			
Courses			
Title	Typ	Hrs/wk	CP
Computer and communication technology in cabin electronics and avionics (L1557)	Lecture	2	2
Computer and communication technology in cabin electronics and avionics (L1558)	Recitation Section (small)	1	1
Model-Based Systems Engineering (MBSE) with SysML/UML (L1551)	Project-/problem-based Learning	3	3
Module Responsible	Prof. Ralf God		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems Previous knowledge in: <ul style="list-style-type: none"> • Systems Engineering 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • describe the structure and operation of computer architectures • explain the structure and operation of digital communication Networks • explain architectures of cabin electronics, integrated modular avionics (IMA) and Aircraft Data Communication Network (ADCN) • understand the approach of Model-Based Systems Engineering (MBSE) in the design of hardware and software-based cabin systems Students are able to: <ul style="list-style-type: none"> • understand, operate and maintain a Minicomputer • build up a network communication and communicate with other network participants • connect a minicomputer with a cabin management system (A380 CIDS) and communicate over a AFDX®-Network • model system functions by means of formal languages SysML/UML and generate software code from the models • execute software code on a minicomputer Students are able to: <ul style="list-style-type: none"> • elaborate partial results and merge with others to form a complete solution Students are able to: <ul style="list-style-type: none"> • organize and schedule their practical tasks 		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 minutes		
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory		

Course L1557: Computer and communication technology in cabin electronics and avionics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

Course L1558: Computer and communication technology in cabin electronics and avionics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge of computer and communication technology in electronic systems in the cabin and in aircraft. For the system engineer the strong interaction of software, mechanical and electronic system components nowadays requires a basic understanding of cabin electronics and avionics.</p> <p>The course teaches the basics of design and functionality of computers and data networks. Subsequently it focuses on current principles and applications in integrated modular avionics (IMA), aircraft data communication networks (ADCN), cabin electronics and cabin networks:</p> <ul style="list-style-type: none"> • History of computer and network technology • Layer model in computer technology • Computer architectures (PC, IPC, Embedded Systems) • BIOS, UEFI and operating system (OS) • Programming languages (machine code and high-level languages) • Applications and Application Programming Interfaces • External interfaces (serial, USB, Ethernet) • Layer model in network technology • Network topologies • Network components • Bus access procedures • Integrated Modular Avionics (IMA) and Aircraft Data Communication Networks (ADCN) • Cabin electronics and cabin networks
Literature	<p>- Skript zur Vorlesung</p> <p>- Schnabel, P.: Computertechnik-Fibel: Grundlagen Computertechnik, Mikroprozessortechnik, Halbleiterspeicher, Schnittstellen und Peripherie. Books on Demand; 1. Auflage, 2003</p> <p>- Schnabel, P.: Netzwerktechnik-Fibel: Grundlagen, Übertragungstechnik und Protokolle, Anwendungen und Dienste, Sicherheit. Books on Demand; 1. Auflage, 2004</p> <p>- Wüst, K.: Mikroprozessortechnik: Grundlagen, Architekturen und Programmierung von Mikroprozessoren, Mikrocontrollern und Signalprozessoren. Vieweg Verlag; 2. aktualisierte und erweiterte Auflage, 2006</p>

Course L1551: Model-Based Systems Engineering (MBSE) with SysML/UML	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	<p>Objectives of the problem-oriented course are the acquisition of knowledge on system design using the formal languages SysML/UML, learning about tools for modeling and finally the implementation of a project with methods and tools of Model-Based Systems Engineering (MBSE) on a realistic hardware platform (e.g. Arduino®, Raspberry Pi®):</p> <ul style="list-style-type: none"> • What is a model? • What is Systems Engineering? • Survey of MBSE methodologies • The modelling languages SysML /UML • Tools for MBSE • Best practices for MBSE • Requirements specification, functional architecture, specification of a solution • From model to software code • Validation and verification: XIL methods • Accompanying MBSE project
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - Weilkiens, T.: Systems Engineering mit SysML/UML: Modellierung, Analyse, Design. 2. Auflage, dpunkt.Verlag, 2008 - Holt, J., Perry, S.A., Brownsword, M.: Model-Based Requirements Engineering. Institution Engineering & Tech, 2011

Module M0511: Electricity Generation from Wind and Hydro Power			
Courses			
Title	Typ	Hrs/wk	CP
Sustainability Management (L0007)	Lecture	2	1
Hydro Power Use (L0013)	Lecture	1	1
Wind Turbine Plants (L0011)	Lecture	2	3
Wind Energy Use - Focus Offshore (L0012)	Lecture	1	1
Module Responsible	Dr. Isabel Höfer		
Admission Requirements	None		
Recommended Previous Knowledge	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II, Module: Fundamentals of Fluid Mechanics		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedure in the implementation of renewable energy projects in countries outside Europe.</p> <p>Through active discussions of various topics within the seminar of the module, students improve their understanding and the application of the theoretical background and are thus able to transfer what they have learned in practice.</p> <p>Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate and assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can in compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects.</p> <p>Students can discuss scientific tasks subject-specificly and multidisciplinary within a seminar.</p> <p>Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of the lecture and to acquire the particular knowledge about the subject area.</p>		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	2.5 hours written exam + Presentation in sustainability management		
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Energy Systems: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0007: Sustainability Management	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	WiSe
Content	<p>The lecture sustainability management provide an insight into the various aspects and dimensions of sustainability. This content of the course is based on the foundations of environmental assessment; therefore the previous attendance of the lecture environmental assessment is recommended. Various valuation approaches for assessing environmental, economic and social aspects are presented. Their application and use for a sustainability management's discussion is explained by means of short technology examples and is later comprehensively presented through case examples.</p> <ul style="list-style-type: none"> • Introduction to the topic of sustainability • Dimensions of sustainability: <ul style="list-style-type: none"> ◦ ecology ◦ economics ◦ social • Transition from the environmental assessment for sustainability management • Case Studies • Excursion <p>Objective: The aim of the course is to learn methods for the assessment of sustainability aspects and apply for sustainability management.</p>
Literature	<p>Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage</p> <p>Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.</p>

Course L0013: Hydro Power Use	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Stefan Achleitner, Hugo Götsch
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Introduction, importance of water power in the national and global context • Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies • Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems • Construction of hydroelectric power plants: description of the individual components and their technical system interaction • Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. • Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection • Hydropower and the Environment • Examples from practice
Literature	<ul style="list-style-type: none"> • Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage • Quaschnig, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage • Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage • von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage • Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006

Course L0011: Wind Turbine Plants	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Rudolf Zellermann, Dr. Jochen Oexmann
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Historical development • Wind: origins, geographic and temporal distribution, locations • Power coefficient, rotor thrust • Aerodynamics of the rotor • Operating performance • Power limitation, partial load, pitch and stall control • Plant selection, yield prediction, economy • Excursion
Literature	Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005

Course L0012: Wind Energy Use - Focus Offshore	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Skiba
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering • Physical fundamentals for utilization of wind energy • Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships • Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures • Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection • Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics • Development and planning of offshore wind farms • Operation and optimization of offshore wind farms • Day excursion
Literature	<ul style="list-style-type: none"> • Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage • Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidelberg, 1997, 3. Auflage • Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage • Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage • Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

Module M0630: Robotics and Navigation in Medicine				
Courses				
Title	Typ		Hrs/wk	CP
Robotics and Navigation in Medicine (L0335)	Lecture		2	3
Robotics and Navigation in Medicine (L0338)	Project Seminar		2	2
Robotics and Navigation in Medicine (L0336)	Recitation Section (small)		1	1
Module Responsible	Prof. Alexander Schlaefer			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none"> principles of math (algebra, analysis/calculus) principles of programming, e.g., in Java or C++ solid R or Matlab skills 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> The students can explain kinematics and tracking systems in clinical contexts and illustrate systems and their components in detail. Systems can be evaluated with respect to collision detection and safety and regulations. Students can assess typical systems regarding design and limitations.</p> <p><i>Skills</i> The students are able to design and evaluate navigation systems and robotic systems for medical applications.</p>			
Personal Competence				
<i>Social Competence</i>	The students discuss the results of other groups, provide helpful feedback and can incorporate feedback into their work.			
<i>Autonomy</i>	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	10 %	Presentation	
	Yes	10 %	Written elaboration	
Examination	Written exam			
Examination duration and scale	90 minutes			
Assignment for the Following Curricula	<p>Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory</p> <p>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Electrical Engineering: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory</p> <p>Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory</p>			

Course L0335: Robotics and Navigation in Medicine	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - kinematics - calibration - tracking systems - navigation and image guidance - motion compensation <p>The seminar extends and complements the contents of the lecture with respect to recent research results.</p>
Literature	<p>Spong et al.: Robot Modeling and Control, 2005</p> <p>Troccaz: Medical Robotics, 2012</p> <p>Further literature will be given in the lecture.</p>

Course L0338: Robotics and Navigation in Medicine	
Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0336: Robotics and Navigation in Medicine	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0764: Flight Control Systems (FS2)				
Courses				
Title			Typ	
Aircraft Systems II (L0736)			Lecture	3
Aircraft Systems II (L0740)			Recitation Section (large)	2
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	basic knowledge of: <ul style="list-style-type: none"> • mathematics • mechanics • thermo dynamics • electronics • fluid technology • control technology 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students are able to... <ul style="list-style-type: none"> • describe the structure of primary flight control systems as well as actuation-, avionic-, high lift systems in general along with corresponding properties and applications. • explain different configurations and designs and their origins • 			
<i>Skills</i>	Students are able to... <ul style="list-style-type: none"> • size primary flight control actuation systems • perform a controller design process for the flight control actuators • design high-lift kinematics 			
Personal Competence				
<i>Social Competence</i>	Students are able to: <ul style="list-style-type: none"> • Develop joint solutions in mixed teams 			
<i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • derive requirements and perform appropriate yet simplified design processes for aircraft systems from complex issues and circumstances in a self-reliant manner 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	165 Minutes			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0736: Aircraft Systems II	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Actuation (Principles of actuators; electro-mechanical actuators; modeling, analysis and sizing of position control systems; hydro-mechanic actuation systems) • Flight Control Systems (control surfaces, hinge moments; requirements of stability and controllability, actuation power; principles of reversible and irreversible flight control systems; servo actuation systems) • Landing Gear Systems (Configurations and geometries; analysis of landing gear systems with respect to damper dynamics, dynamics of the breaking aircraft and power consumption; design and analysis of breaking systems with respect to energy and heat; anti-skid systems) • Fuel Systems (Architectures; aviation fuels; system components; fueling system; tank inerting system; fuel management; trim tank) • De- and Anti-Ice Systems: (Atmospheric icing conditions; principles of de- and anti-ice systems)
Literature	<ul style="list-style-type: none"> • Moir, Seabridge: Aircraft Systems • Torenbek: Synthesis of Subsonic Airplane Design • Curry: Aircraft Landing Gear Design: Principles and Practices

Course L0740: Aircraft Systems II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0811: Medical Imaging Systems				
Courses				
Title	Typ		Hrs/wk	CP
Medical Imaging Systems (L0819)	Lecture		4	6
Module Responsible	Dr. Michael Grass			
Admission Requirements	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	<p>Students can:</p> <ul style="list-style-type: none"> Describe the system configuration and components of the main clinical imaging systems; Explain how the system components and the overall system of the imaging systems function; Explain and apply the physical processes that make imaging possible and use with the fundamental physical equations; Name and describe the physical effects required to generate image contrasts; Explain how spatial and temporal resolution can be influenced and how to characterize the images generated; Explain which image reconstruction methods are used to generate images; <p>Describe and explain the main clinical uses of the different systems.</p>			
<i>Skills</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> Explain the physical processes of images and assign to the systems the basic mathematical or physical equations required; <ul style="list-style-type: none"> Calculate the parameters of imaging systems using the mathematical or physical equations; Determine the influence of different system components on the spatial and temporal resolution of imaging systems; Explain the importance of different imaging systems for a number of clinical applications; <p>Select a suitable imaging system for an application.</p>			
Personal Competence <i>Social Competence</i>	none			
<i>Autonomy</i>	<p>Students can:</p> <ul style="list-style-type: none"> Understand which physical effects are used in medical imaging; Decide independently for which clinical issue a measuring system can be used. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	<p>Electrical Engineering: Specialisation Medical Technology: Elective Compulsory</p> <p>Biomedical Engineering: Core Qualification: Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Bio- and Medical Technology: Elective Compulsory</p>			

Course L0819: Medical Imaging Systems	
Typ	Lecture
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Dr. Michael Grass, Dr. Sven Prevhal, Dr. Tim Nielsen, Frank Michael Weber
Language	DE
Cycle	SoSe
Content	
Literature	<p>Primary book:</p> <p>1. P. Suetens, "Fundamentals of Medical Imaging", Cambridge Press</p> <p>Secondary books:</p> <ul style="list-style-type: none"> - A. Webb, "Introduction to Biomedical Imaging", IEEE Press 2003. - W.R. Hendee and E.R. Ritenour, "Medical Imaging Physics", Wiley-Liss, New York, 2002. - H. Morneburg (Edt), "Bildgebende Systeme für die medizinische Diagnostik", Erlangen: Siemens Publicis MCD Verlag, 1995. - O. Dössel, "Bildgebende Verfahren in der Medizin", Springer Verlag Berlin, 2000.

Module M1156: Systems Engineering				
Courses				
Title	Typ		Hrs/wk	CP
Systems Engineering (L1547)	Lecture		3	4
Systems Engineering (L1548)	Recitation Section (large)		1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous Knowledge	<p>Basic knowledge in:</p> <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems <p>Previous knowledge in:</p> <ul style="list-style-type: none"> • Aircraft Cabin Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> • understand systems engineering process models, methods and tools for the development of complex Systems • describe innovation processes and the need for technology Management • explain the aircraft development process and the process of type certification for aircraft • explain the system development process, including requirements for systems reliability • identify environmental conditions and test procedures for airborne Equipment • value the methodology of requirements-based engineering (RBE) and model-based requirements engineering (MBRE) 			
<i>Skills</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> • plan the process for the development of complex Systems • organize the development phases and development Tasks • assign required business activities and technical Tasks • apply systems engineering methods and tools 			
Personal Competence <i>Social Competence</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> • understand their responsibilities within a development team and integrate themselves with their role in the overall process 			
<i>Autonomy</i>	<p>Students are able to:</p> <ul style="list-style-type: none"> • interact and communicate in a development team which has distributed tasks 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes			
Assignment for the Following Curricula	<p>Aircraft Systems Engineering: Core Qualification: Compulsory</p> <p>International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory</p> <p>International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory</p> <p>Mechatronics: Specialisation System Design: Elective Compulsory</p> <p>Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory</p>			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1547: Systems Engineering	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	<p>The objective of the lecture with the corresponding exercise is to accomplish the prerequisites for the development and integration of complex systems using the example of commercial aircraft and cabin systems. Competences in the systems engineering process, tools and methods is to be achieved. Regulations, guidelines and certification issues will be known.</p> <p>Key aspects of the course are processes for innovation and technology management, system design, system integration and certification as well as tools and methods for systems engineering:</p> <ul style="list-style-type: none"> • Innovation processes • IP-protection • Technology management • Systems engineering • Aircraft program • Certification issues • Systems development • Safety objectives and fault tolerance • Environmental and operating conditions • Tools for systems engineering • Requirements-based engineering (RBE) • Model-based requirements engineering (MBRE)
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - diverse Normen und Richtlinien (EASA, FAA, RTCA, SAE) - Hauschildt, J., Salomo, S.: Innovationsmanagement. Vahlen, 5. Auflage, 2010 - NASA Systems Engineering Handbook, National Aeronautics and Space Administration, 2007 - Hinsch, M.: Industrielles Luftfahrtmanagement: Technik und Organisation luftfahrttechnischer Betriebe. Springer, 2010 - De Florio, P.: Airworthiness: An Introduction to Aircraft Certification. Elsevier Ltd., 2010 - Pohl, K.: Requirements Engineering. Grundlagen, Prinzipien, Techniken. 2. korrigierte Auflage, dpunkt.Verlag, 2008

Course L1548: Systems Engineering	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1161: Turbomachinery				
Courses				
Title	Typ		Hrs/wk	CP
Turbomachines (L1562)	Lecture		3	4
Turbomachines (L1563)	Recitation Section (large)		1	2
Module Responsible	Prof. Markus Schatz			
Admission Requirements	None			
Recommended Previous Knowledge	Technical Thermodynamics I, II, Fluid Dynamics, Heat Transfer			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	<p>The students can</p> <ul style="list-style-type: none"> distinguish the physical phenomena of conversion of energy, understand the different mathematic modelling of turbomachinery, calculate and evaluate turbomachinery. 			
<i>Skills</i>	<p>The students are able to</p> <ul style="list-style-type: none"> understand the physics of Turbomachinery, solve excersises self-consistent. 			
Personal Competence				
<i>Social Competence</i>	<p>The students are able to</p> <ul style="list-style-type: none"> discuss in small groups and develop an approach. 			
<i>Autonomy</i>	<p>The students are able to</p> <ul style="list-style-type: none"> develop a complex problem self-consistent, analyse the results in a critical way, have an qualified exchange with other students. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	<p>Energy Systems: Specialisation Energy Systems: Elective Compulsory</p> <p>Energy Systems: Specialisation Marine Engineering: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p>			

Course L1562: Turbomachines	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Markus Schatz
Language	DE
Cycle	SoSe
Content	<p>Topics to be covered will include:</p> <ul style="list-style-type: none"> Application cases of turbomachinery Fundamentals of thermodynamics and fluid mechanics Design fundamentals of turbomachinery Introduction to the theory of turbine stage Design and operation of the turbocompressor Design and operation of the steam turbine Design and operation of the gas turbine Physical limits of the turbomachines
Literature	<ul style="list-style-type: none"> Traupel: Thermische Turbomaschinen, Springer. Berlin, Heidelberg, New York Bräunling: Flugzeuggasturbinen, Springer., Berlin, Heidelberg, New York Seume: Stationäre Gasturbinen, Springer., Berlin, Heidelberg, New York Menny: Strömungsmaschinen, Teubner., Stuttgart

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1563: Turbomachines	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Markus Schatz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1226: Mechanical Properties			
Courses			
Title	Typ	Hrs/wk	CP
Mechanical Behaviour of Brittle Materials (L1661)	Lecture	2	3
Dislocation Theory of Plasticity (L1662)	Lecture	2	3
Module Responsible	Dr. Erica Lilleodden		
Admission Requirements	None		
Recommended Previous Knowledge	Basics in Materials Science I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p>Students can explain basic principles of crystallography, statics (free body diagrams, tractions) and thermodynamics (energy minimization, energy barriers, entropy)</p> <p>Students are capable of using standardized calculation methods: tensor calculations, derivatives, integrals, tensor transformations</p> <p>Students can provide appropriate feedback and handle feedback on their own performance constructively.</p> <p>Students are able to</p> <ul style="list-style-type: none"> - assess their own strengths and weaknesses - assess their own state of learning in specific terms and to define further work steps on this basis guided by teachers. - work independently based on lectures and notes to solve problems, and to ask for help or clarifications when needed 		
<i>Knowledge</i>			
<i>Skills</i>			
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	<p>Materials Science: Core Qualification: Compulsory</p> <p>Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Production: Elective Compulsory</p> <p>Product Development, Materials and Production: Specialisation Materials: Compulsory</p> <p>Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory</p> <p>Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory</p>		

Course L1661: Mechanical Behaviour of Brittle Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Gerold Schneider
Language	DE/EN
Cycle	SoSe
Content	<p>Theoretical Strength Of a perfect crystalline material, theoretical critical shear stress</p> <p>Real strength of brittle materials Energy release reate, stress intensity factor, fracture criterion</p> <p>Scattering of strength of brittle materials Defect distribution, strength distribution, Weibull distribution</p> <p>Heterogeneous materials I Internal stresses, micro cracks, weight function,</p> <p>Heterogeneous materials II Toughening mechanisms: crack bridging, fibres</p> <p>Heterogeneous materials III Toughening mechanisms. Process zone</p> <p>Testing methods to determine the fracture toughness of brittle materials</p> <p>R-curve, stable/unstable crack growth, fractography</p> <p>Thermal shock</p> <p>Subcritical crack growth) v-K-curve, life time prediction</p> <p>Kriechen</p> <p>Mechanical properties of biological materials</p> <p>Examples of use for a mechanically reliable design of ceramic components</p>
Literature	<p>D R H Jones, Michael F. Ashby, Engineering Materials 1, An Introduction to Properties, Applications and Design, Elsevier</p> <p>D.J. Green, An introduction to the mechanical properties of ceramics", Cambridge University Press, 1998</p> <p>B.R. Lawn, Fracture of Brittle Solids", Cambridge University Press, 1993</p> <p>D. Munz, T. Fett, Ceramics, Springer, 2001</p> <p>D.W. Richerson, Modern Ceramic Engineering, Marcel Decker, New York, 1992</p>

Course L1662: Dislocation Theory of Plasticity	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Erica Lilleodden
Language	DE/EN
Cycle	SoSe
Content	<p>This class will cover the principles of dislocation theory from a physical metallurgy perspective, providing a fundamental understanding of the relations between the strength and of crystalline solids and distributions of defects.</p> <p>We will review the concept of dislocations, defining terminology used, and providing an overview of important concepts (e.g. linear elasticity, stress-strain relations, and stress transformations) for theory development. We will develop the theory of dislocation plasticity through derived stress-strain fields, associated self-energies, and the induced forces on dislocations due to internal and externally applied stresses. Dislocation structure will be discussed, including core models, stacking faults, and dislocation arrays (including grain boundary descriptions). Mechanisms of dislocation multiplication and strengthening will be covered along with general principles of creep and strain rate sensitivity. Final topics will include non-FCC dislocations, emphasizing the differences in structure and corresponding implications on dislocation mobility and macroscopic mechanical behavior; and dislocations in finite volumes.</p>
Literature	<p>Vorlesungsskript</p> <p>Aktuelle Publikationen</p> <p>Bücher:</p> <p>Introduction to Dislocations, by D. Hull and D.J. Bacon</p> <p>Theory of Dislocations, by J.P. Hirth and J. Lothe</p> <p>Physical Metallurgy, by Peter Hassen</p>

Module M0840: Optimal and Robust Control			
Courses			
Title	Typ	Hrs/wk	CP
Optimal and Robust Control (L0658)	Lecture	2	3
Optimal and Robust Control (L0659)	Recitation Section (small)	2	3
Module Responsible	Prof. Herbert Werner		
Admission Requirements	None		
Recommended Previous Knowledge	<ul style="list-style-type: none"> Classical control (frequency response, root locus) State space methods Linear algebra, singular value decomposition 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <ul style="list-style-type: none"> Students can explain the significance of the matrix Riccati equation for the solution of LQ problems. They can explain the duality between optimal state feedback and optimal state estimation. They can explain how the H2 and H-infinity norms are used to represent stability and performance constraints. They can explain how an LQG design problem can be formulated as special case of an H2 design problem. They can explain how model uncertainty can be represented in a way that lends itself to robust controller design They can explain how - based on the small gain theorem - a robust controller can guarantee stability and performance for an uncertain plant. They understand how analysis and synthesis conditions on feedback loops can be represented as linear matrix inequalities. <i>Skills</i> <ul style="list-style-type: none"> Students are capable of designing and tuning LQG controllers for multivariable plant models. They are capable of representing a H2 or H-infinity design problem in the form of a generalized plant, and of using standard software tools for solving it. They are capable of translating time and frequency domain specifications for control loops into constraints on closed-loop sensitivity functions, and of carrying out a mixed-sensitivity design. They are capable of constructing an LFT uncertainty model for an uncertain system, and of designing a mixed-objective robust controller. They are capable of formulating analysis and synthesis conditions as linear matrix inequalities (LMI), and of using standard LMI-solvers for solving them. They can carry out all of the above using standard software tools (Matlab robust control toolbox). Personal Competence <i>Social Competence</i> Students can work in small groups on specific problems to arrive at joint solutions. <i>Autonomy</i> Students are able to find required information in sources provided (lecture notes, literature, software documentation) and use it to solve given problems.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Oral exam		
Examination duration and scale	30 min		
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Core Qualification: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0658: Optimal and Robust Control	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> • Optimal regulator problem with finite time horizon, Riccati differential equation • Time-varying and steady state solutions, algebraic Riccati equation, Hamiltonian system • Kalman's identity, phase margin of LQR controllers, spectral factorization • Optimal state estimation, Kalman filter, LQG control • Generalized plant, review of LQG control • Signal and system norms, computing H_2 and H_∞ norms • Singular value plots, input and output directions • Mixed sensitivity design, H_∞ loop shaping, choice of weighting filters • Case study: design example flight control • Linear matrix inequalities, design specifications as LMI constraints (H_2, H_∞ and pole region) • Controller synthesis by solving LMI problems, multi-objective design • Robust control of uncertain systems, small gain theorem, representation of parameter uncertainty
Literature	<ul style="list-style-type: none"> • Werner, H., Lecture Notes: "Optimale und Robuste Regelung" • Boyd, S., L. El Ghaoui, E. Feron and V. Balakrishnan "Linear Matrix Inequalities in Systems and Control", SIAM, Philadelphia, PA, 1994 • Skogestad, S. and I. Postlewaite "Multivariable Feedback Control", John Wiley, Chichester, England, 1996 • Strang, G. "Linear Algebra and its Applications", Harcourt Brace Jovanovic, Orlando, FA, 1988 • Zhou, K. and J. Doyle "Essentials of Robust Control", Prentice Hall International, Upper Saddle River, NJ, 1998

Course L0659: Optimal and Robust Control	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1343: Fibre-polymer-composites			
Courses			
Title	Typ	Hrs/wk	CP
Structure and properties of fibre-polymer-composites (L1894)	Lecture	2	3
Design with fibre-polymer-composites (L1893)	Lecture	2	3
Module Responsible	Prof. Bodo Fiedler		
Admission Requirements	None		
Recommended Previous Knowledge	Basics: chemistry / physics / materials science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	<p>Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents to play (fiber / matrix) and define the necessary testing and analysis.</p> <p>They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection).</p> <p>Students are capable of</p> <ul style="list-style-type: none"> • using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. • approximate sizing using the network theory of the structural elements implement and evaluate. • selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance. <p>Students can</p> <ul style="list-style-type: none"> • arrive at funded work results in heterogenius groups and document them. • provide appropriate feedback and handle feedback on their own performance constructively. <p>Students are able to</p> <ul style="list-style-type: none"> - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 min		
Assignment for the Following Curricula	Energy Systems: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Renewable Energies: Specialisation Wind Energy Systems: Elective Compulsory Renewable Energies: Specialisation Solar Energy Systems: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1894: Structure and properties of fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	<ul style="list-style-type: none"> - Microstructure and properties of the matrix and reinforcing materials and their interaction - Development of composite materials - Mechanical and physical properties - Mechanics of Composite Materials - Laminate theory - Test methods - Non destructive testing - Failure mechanisms - Theoretical models for the prediction of properties - Application
Literature	Hall, Clyne: Introduction to Composite materials, Cambridge University Press Daniel, Ishai: Engineering Mechanics of Composites Materials, Oxford University Press Mallick: Fibre-Reinforced Composites, Marcel Dekker, New York

Course L1893: Design with fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	EN
Cycle	SoSe
Content	Designing with Composites: Laminate Theory; Failure Criteria; Design of Pipes and Shafts; Sandwich Structures; Notches; Joining Techniques; Compression Loading; Examples
Literature	Konstruieren mit Kunststoffen, Gunter Erhard , Hanser Verlag

Module M1344: Processing of fibre-polymer-composites			
Courses			
Title	Typ	Hrs/wk	CP
Processing of fibre-polymer-composites (L1895)	Lecture	2	3
From Molecule to Composites Part (L1516)	Project/problem-based Learning	2	3
Module Responsible	Prof. Bodo Fiedler		
Admission Requirements	None		
Recommended Previous Knowledge	Knowledge in the basics of chemistry / physics / materials science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	<p><i>Knowledge</i> Students are able to give a summary of the technical details of the manufacturing processes composites and illustrate respective relationships. They are capable of describing and communicating relevant problems and questions using appropriate technical language. They can explain the typical process of solving practical problems and present related results.</p> <p><i>Skills</i> Students can use the knowledge of fiber-reinforced composites (FRP) and its constituents (fiber / matrix) and define the necessary testing and analysis.</p> <p>They can explain the complex structure-property relationship and the interactions of chemical structure of the polymers, their processing with the different fiber types, including to explain neighboring contexts (e.g. sustainability, environmental protection).</p> <p>Personal Competence</p> <p><i>Social Competence</i> Students are able to cooperate in small, mixed-subject groups in order to independently derive solutions to given problems in the context of civil engineering. They are able to effectively present and explain their results alone or in groups in front of a qualified audience. Students have the ability to develop alternative approaches to an engineering problem independently or in groups and discuss advantages as well as drawbacks.</p> <p><i>Autonomy</i> Students are capable of independently solving mechanical engineering problems using provided literature. They are able to fill gaps in as well as extent their knowledge using the literature and other sources provided by the supervisor. Furthermore, they can meaningfully extend given problems and pragmatically solve them by means of corresponding solutions and concepts.</p>		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Mechanical Engineering and Management: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Course L1895: Processing of fibre-polymer-composites	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	Manufacturing of Composites: Hand Lay-Up; Pre-Preg; GMT, BMC; SMC, RIM; Pultrusion; Filament Winding
Literature	Åström: Manufacturing of Polymer Composites, Chapman and Hall

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1516: From Molecule to Composites Part	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler
Language	DE/EN
Cycle	SoSe
Content	<p>Students get the task in the form of a customer request for the development and production of a MTB handlebar made of fiber composites. In the task technical and normative requirements (standards) are given, all other required information come from the lectures and tutorials, and the respective documents (electronically and in conversation).</p> <p>The procedure is to specify in a milestone schedule and allows students to plan tasks and to work continuously. At project end, each group has a made handlebar with approved quality.</p> <p>In each project meeting the design (discussion of the requirements and risks) are discussed. The calculations are analyzed, evaluated and established manufacturing methods are selected. Materials are selected bar will be produced. The quality and the mechanical properties are checked. At the end of the final report created (compilation of the results for the "customers").</p> <p>After the test during the "customer / supplier conversation" there is a mutual feedback-talk ("lessons learned") in order to ensure the continuous improvement.</p>
Literature	Customer Request ("Handout")

Module M1174: Automation Technology and Systems							
Courses							
Title		Typ	Hrs/wk	CP			
Automation Technology and Systems (L2329)		Lecture	4	4			
Automation Technology and Systems (L2331)		Project-/problem-based Learning	1	1			
Automation Technology and Systems (L2330)		Recitation Section (small)	1	1			
Module Responsible	Prof. Thorsten Schüppstuhl						
Admission Requirements	None						
Recommended Previous Knowledge	without major course assessment						
Educational Objectives	After taking part successfully, students have reached the following learning results						
Professional Competence							
Knowledge					Students <ul style="list-style-type: none">know the characteristic components of an automation systems and have good understanding of their interactionknow methods for a systematical analysis of automation tasks and are able to use themhave special competences in industrial robot based automation systems		
Skills					Students are able to... <ul style="list-style-type: none">analyze complex Automation tasksdevelop application based concepts and solutionsdesign subsystems and integrate into one systeminvestigate and evaluate safety of machinerycreate simple programs for robots and programmable logic controllersdesign of circuit for pneumatic applications		
Personal Competence							
Social Competence					Students are able to ... <ul style="list-style-type: none">find solutions for automation and handling tasks in groupsdevelop solutions in a production environment with qualified personnel at technical level and represent decisions.		
Autonomy					Students are able to ... <ul style="list-style-type: none">analyze automation tasks independentlygenerate programs for robots and programmable logic devices autonomouslydevelop solutions for practice oriented tasks of automation independentlydesign safety concepts for automation applicationsassess consequences of their professional actions and responsibilities		
Workload in Hours					Independent Study Time 96, Study Time in Lecture 84		
Credit points					6		
Course achievement					None		
Examination					Written exam		
Examination duration and scale					120 min		
Assignment for the Following Curricula					Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L2329: Automation Technology and Systems	
Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2331: Automation Technology and Systems	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2330: Automation Technology and Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Thorsten Schüppstuhl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module Manual M.Sc. "Product Development, Materials and Production"

Module M0563: Robotics			
Courses			
Title	Typ	Hrs/wk	CP
Robotics: Modelling and Control (L0168)	Integrated Lecture	4	4
Robotics: Modelling and Control (L1305)	Project-/problem-based Learning	2	2
Module Responsible	Dr. Martin Gomse		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of electrical engineering Broad knowledge of mechanics Fundamentals of control theory		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to describe fundamental properties of robots and solution approaches for multiple problems in robotics. Students are able to derive and solve equations of motion for various manipulators. Students can generate trajectories in various coordinate systems. Students can design linear and partially nonlinear controllers for robotic manipulators. Students are able to work goal-oriented in small mixed groups. Students are able to recognize and improve knowledge deficits independently. With instructor assistance, students are able to evaluate their own knowledge level and define a further course of study.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	120 min		
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Compulsory Aircraft Systems Engineering: Specialisation Aircraft Systems: Elective Compulsory International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory		

Course L0168: Robotics: Modelling and Control	
Typ	Integrated Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Dr. Martin Gomse
Language	EN
Cycle	WiSe
Content	Fundamental kinematics of rigid body systems Newton-Euler equations for manipulators Trajectory generation Linear and nonlinear control of robots
Literature	Craig, John J.: Introduction to Robotics Mechanics and Control, Third Edition, Prentice Hall. ISBN 0201-54361-3 Spong, Mark W.; Hutchinson, Seth; Vidyasagar, M. : Robot Modeling and Control. WILEY. ISBN 0-471-64990-2

Course L1305: Robotics: Modelling and Control	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Martin Gomse
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0771: Flight Physics				
Courses				
Title		Typ	Hrs/wk	CP
Aerodynamics and Flight Mechanics I (L0727)		Lecture	3	3
Flight Mechanics II (L0730)		Lecture	2	2
Flight Mechanics II (L0731)		Recitation Section (large)	1	1
Module Responsible	Prof. Frank Thielecke			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none">MathematicsMechanicsThermodynamicsAviation			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence Knowledge Skills Personal Competence Social Competence Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes (WS) + 90 Minutes (SS)			
Assignment for the Following Curricula	Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L0727: Aerodynamics and Flight Mechanics I	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Frank Thielecke, Dr. Ralf Heinrich, Mike Montel
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none">Aerodynamics (fundamental equations of aerodynamics; compressible and incompressible flows; airfoils and wings; viscous flows)Flight Mechanics (Equations of motion; flight performance; control surfaces; derivatives; lateral stability and control; trim conditions; flight maneuvers)
Literature	<ul style="list-style-type: none">Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und IIEtkin, B.: Dynamics of Atmospheric FlightSachs/Hafer: FlugmechanikBrockhaus: FlugregelungJ.D. Anderson: Introduction to flight

Course L0730: Flight Mechanics II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	<ul style="list-style-type: none"> • stationary asymmetric flight • dynamics of lateral movement • methods of flight simulation • experimental methods of flight mechanics • model validation using system identification • wind tunnel techniques
Literature	<ul style="list-style-type: none"> • Schlichting, H.; Truckenbrodt, E.: Aerodynamik des Flugzeuges I und II • Etkin, B.: Dynamics of Atmospheric Flight • Sachs/Hafer: Flugmechanik • Brockhaus: Flugregelung • J.D. Anderson: Introduction to flight

Course L0731: Flight Mechanics II	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Thielecke
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0815: Product Planning				
Courses				
Title			Typ	Hrs/wk CP
Product Planning (L0851)			Lecture	3 3
Product Planning Seminar (L0853)			Project-/problem-based Learning	2 3
Module Responsible	Prof. Cornelius Herstatt			
Admission Requirements	None			
Recommended Previous Knowledge	Good basic-knowledge of Business Administration			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
<i>Knowledge</i>	Students will gain insights into:			
	<ul style="list-style-type: none"> Product Planning <ul style="list-style-type: none"> Process Methods Design thinking <ul style="list-style-type: none"> Process Methods User integration 			
<i>Skills</i>	Students will gain deep insights into:			
	<ul style="list-style-type: none"> Product Planning <ul style="list-style-type: none"> Process-related aspects Organisational-related aspects Human-Ressource related aspects Working-tools, methods and instruments 			
Personal Competence				
<i>Social Competence</i>	<ul style="list-style-type: none"> Interact within a team Raise awareness for globabl issues 			
<i>Autonomy</i>	<ul style="list-style-type: none"> Gain access to knowledge sources Interpret complex cases Develop presentation skills 			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	20 %	Subject	theoretical and practical work
Examination	Written exam			
Examination duration and scale	90 minutes			
Assignment for the Following Curricula	Global Innovation Management: Core Qualification: Compulsory International Management and Engineering: Specialisation I. Electives Management: Elective Compulsory Mechanical Engineering and Management: Specialisation Management: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0851: Product Planning	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	<p>Product Planning Process</p> <p>This integrated lecture is designed to understand major issues, activities and tools in the context of systematic product planning, a key activity for managing the front-end of innovation, i.e.:</p> <ul style="list-style-type: none"> • Systematic scanning of markets for innovation opportunities • Understanding strengths/weakness and specific core competences of a firm as platforms for innovation • Exploring relevant sources for innovation (customers, suppliers, Lead Users, etc.) • Developing ideas for radical innovation, relying on the creativeness of employees, using techniques to stimulate creativity and creating a stimulating environment • Transferring ideas for innovation into feasible concepts which have a high market attractively <p>Voluntary presentations in the third hour (articles / case studies)</p> <ul style="list-style-type: none"> - Guest lectures by researchers - Lecture on Sustainability with frequent reference to current research - Permanent reference to current research <p>Examination:</p> <p>In addition to the written exam at the end of the module, students have to attend the PBL-exercises and prepare presentations in groups in order to pass the module. Additionally, students have the opportunity to present research papers on a voluntary base. With these presentations it is possible to gain a bonus of max. 20% for the exam. However, the bonus is only valid if the exam is passed without the bonus.</p>
Literature	Ulrich, K./Eppinger, S.: Product Design and Development, 2nd. Edition, McGraw-Hill 2010

Course L0853: Product Planning Seminar	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Cornelius Herstatt
Language	EN
Cycle	WiSe
Content	Seminar is integrative part of the Module Product Planning (for content see lecture) and can not be chosen independantly.
Literature	See lecture information "Product Planning".

Module M0830: Environmental Protection and Management				
Courses				
Title		Typ	Hrs/wk	CP
Integrated Pollution Control (L0502)		Lecture	2	2
Health, Safety and Environmental Management (L0387)		Lecture	2	3
Health, Safety and Environmental Management (L0388)		Recitation Section (small)	1	1
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous Knowledge	<ul style="list-style-type: none">• Good knowledge in Technologies for Environmental Protection (end-of-pipe, integrated solutions)• Good knowledge of the relevant Environmental Legislation• Basic knowledge of instruments for Environmental Assessment			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	Knowledge	The students are able to describe the basics of regulations, economic instruments, voluntary initiatives, fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements. They can analyse and discuss industrial processes, substance cycles and approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their sound knowledge of complex industry related problems. They are able to judge environmental issues and to widely consider, apply or carry out innovative technical solutions, remediation measures and further interventions as well as conceptual problem solving approaches in the full range of problems in different industrial sectors.		
	Skills	Students are able to assess current problems and situations in the field of environmental protection. They can consider the best available techniques and to plan and suggest concrete actions in a company- or branch-specific context. By this means they can solve problems on a technical, administrative and legislative level.		
	Personal Competence	Social Competence	The students can work together in international groups.	
Autonomy	Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. They can acquire appropriate knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory Environmental Engineering: Core Qualification: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Energy: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Compulsory Water and Environmental Engineering: Specialisation Cities: Compulsory			

Course L0502: Integrated Pollution Control	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<p>The lecture focusses on:</p> <ul style="list-style-type: none"> • The Regulatory Framework • Pollution & Impacts, Characteristics of Pollutants • Approaches of Integrated Pollution Control • Sevilla Process, Best Available Technologies & BREF Documents • Case Studies: paper industry, cement industry, automotive industry • Field Trip
Literature	<p>Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0</p> <p>Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3</p>

Course L0387: Health, Safety and Environmental Management	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Objectives of and benefit from HSE management • From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives • Fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements Environmental performance evaluation Risk management: hazard, risk and safety Health and safety at the workplace • Crisis management
Literature	<p>C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315)</p> <p>Exercises can be downloaded from StudIP</p>

Course L0388: Health, Safety and Environmental Management	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0867: Production Planning & Control and Digital Enterprise			
Courses			
Title	Typ	Hrs/wk	CP
The Digital Enterprise (L0932)	Lecture	2	2
Production Planning and Control (L0929)	Lecture	2	2
Production Planning and Control (L0930)	Recitation Section (small)	1	1
Exercise: The Digital Enterprise (L0933)	Recitation Section (small)	1	1
Module Responsible	Prof. Hermann Lödging		
Admission Requirements	None		
Recommended Previous Knowledge	Fundamentals of Production and Quality Management		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	Students can explain the contents of the module in detail and take a critical position to them. Students are capable of choosing and applying models and methods from the module to industrial problems. Students can develop joint solutions in mixed teams and present them to others. -		
Knowledge			
Skills			
Personal Competence			
Social Competence	Students can develop joint solutions in mixed teams and present them to others.		
Autonomy	-		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 Minuten		
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Logistics, Infrastructure and Mobility: Specialisation Production and Logistics: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Course L0932: The Digital Enterprise	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	Due to the developments of Industry 4.0, digitalization and interconnectivity become a strategic advantage for companies in the international competition. This lecture focuses on the relevant modules and enables the participants to evaluate current developments in this context. In particular, knowledge management, simulation, process modelling and virtual technologies are covered. Content: <ul style="list-style-type: none">• Business Process Management and Data Modelling, Simulation• Knowledge and Competence Management• Process Management (PPC, Workflow Management)• Computer Aided Planning (CAP) and NC-Programming• Virtual Reality (VR) and Augmented Reality (AR)• Computer Aided Quality Management (CAQ)• Industry 4.0
Literature	Scheer, A.-W.: ARIS - vom Geschäftsprozeß zum Anwendungssystem. Springer-Verlag, Berlin 4. Aufl. 2002 Schuh, G. et. al.: Produktionsplanung und -steuerung, Springer-Verlag. Berlin 3. Auflage 2006 Becker, J.; Luczak, H.: Workflowmanagement in der Produktionsplanung und -steuerung. Springer-Verlag, Berlin 2004 Pfeifer, T; Schmitt, R.: Masing Handbuch Qualitätsmanagement. Hanser-Verlag, München 5. Aufl. 2007 Kühn, W.: Digitale Fabrik. Hanser-Verlag, München 2006

Course L0929: Production Planning and Control	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Models of Production and Inventory Management • Production Programme Planning and Lot Sizing • Order and Capacity Scheduling • Selected Strategies of PPC • Manufacturing Control • Production Controlling • Supply Chain Management
Literature	<ul style="list-style-type: none"> • Vorlesungsskript • Lödding, H: Verfahren der Fertigungssteuerung, Springer 2008 • Nyhuis, P.; Wiendahl, H.-P.: Logistische Kennlinien, Springer 2002

Course L0930: Production Planning and Control	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Hermann Lödding
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0933: Exercise: The Digital Enterprise	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Axel Friedewald
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	<p>Siehe korrespondierende Vorlesung</p> <p>See interlocking course</p>

Module M0962: Sustainability and Risk Management				
Courses				
Title		Typ	Hrs/wk	CP
Safety, Reliability and Risk Assessment (L1145)		Seminar	2	3
Environment and Sustainability (L0319)		Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous Knowledge	none			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<div>Knowledge</div> <p>Students are able to describe single techniques and to give an overview for the field of safety and risk assessment as well as environmental and sustainable engineering, in detail:</p> <ul style="list-style-type: none">basics in safety and reliability of technical facilitiessafety and reliability analysis methodsrisk assessmentProduction and usage of bio-charenergy production and supplysustainable product design <div>Skills</div> <p>Students are able apply interdisciplinary system-oriented methods for risk assessment and sustainability reporting. They can evaluate the effort and costs for processes and select economically feasible treatment concepts.</p> <div>Personal Competence</div> <div>Social Competence</div> <div>Autonomy</div> <p>Students can gain knowledge of the subject area from given sources and transform it to new questions. Furthermore, they can define targets for new application or research-oriented duties in for risk management and sustainability concepts accordance with the potential social, economic and cultural impact.</p>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	Elaboration and presentation (45 minutes in groups)			
Assignment for the Following Curricula	Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Management and Controlling: Elective Compulsory International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Water and Environmental Engineering: Core Qualification: Compulsory			

Course L1145: Safety, Reliability and Risk Assessment	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski
Language	DE
Cycle	WiSe
Content	<p>An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated:</p> <ul style="list-style-type: none">basics in safety and reliability of technical facilitiessafety and reliability analysis methodsrisk assessmentpractical examples and excursionsdiscussions and presentations
Literature	<p>- Vorlesungsunterlagen</p> <p>- Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/sicherheit_und_zuverlaessigkeit.pdf</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0319: Environment and Sustainability	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	<p>This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list show examples.</p> <p>Production and Usage of Bio-char Energy production with algae Environmental product design Clean Development mechanism (CDM) Democracy and Energy New Concepts for a sustainable Energy Supply</p> <p>Recycling of Wind Turbines Alternative Mobility</p> <p>Disposal of Nuclear Wastes Waste2Energy Offshore Wind energy</p>
Literature	Wird in der Veranstaltung bekannt gegeben.

Module M1024: Methods of Integrated Product Development			
Courses			
Title	Typ	Hrs/wk	CP
Integrated Product Development II (L1254)	Lecture	3	3
Integrated Product Development II (L1255)	Project-/problem-based Learning	2	3
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge of Integrated product development and applying CAE systems		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	After passing the module students are able to: <ul style="list-style-type: none"> • explain technical terms of design methodology, • describe essential elements of construction management, • describe current problems and the current state of research of integrated product development. 		
<i>Skills</i>	After passing the module students are able to: <ul style="list-style-type: none"> • select and apply proper construction methods for non-standardized solutions of problems as well as adapt new boundary conditions, • solve product development problems with the assistance of a workshop based approach, • choose and execute appropriate moderation techniques. 		
Personal Competence			
<i>Social Competence</i>	After passing the module students are able to: <ul style="list-style-type: none"> • prepare and lead team meetings and moderation processes, • work in teams on complex tasks, • represent problems and solutions and advance ideas. 		
<i>Autonomy</i>	After passing the module students are able to: <ul style="list-style-type: none"> • give a structured feedback and accept a critical feedback, • implement the accepted feedback autonomous. 		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70		
Credit points	6		
Course achievement	None		
Examination	Oral exam		
Examination duration and scale	30 Minuten		
Assignment for the Following Curricula	Aircraft Systems Engineering: Specialisation Cabin Systems: Elective Compulsory Aircraft Systems Engineering: Specialisation Air Transportation Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory		

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1254: Integrated Product Development II	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	<p>Lecture</p> <p>The lecture extends and enhances the learned content of the module "Integrated Product Development and lightweight design" and is based on the knowledge and skills acquired there.</p> <p>Topics of the course include in particular:</p> <ul style="list-style-type: none"> • Methods of product development, • Presentation techniques, • Industrial Design, • Design for variety • Modularization methods, • Design catalogs, • Adapted QFD matrix, • Systematic material selection, • Assembly oriented design, <p>Construction management</p> <ul style="list-style-type: none"> • CE mark, declaration of conformity including risk assessment, • Patents, patent rights, patent monitoring • Project management (cost, time, quality) and escalation principles, • Development management for mechatronics, • Technical Supply Chain Management. <p>Exercise (PBL)</p> <p>In the exercise the content presented in the lecture "Integrated Product Development II" and methods of product development and design management will be enhanced.</p> <p>Students learn an independently moderated and workshop based approach through industry related practice examples to solve complex and currently existing issues in product development. They will learn the ability to apply important methods of product development and design management autonomous and acquire further expertise in the field of integrated product development. Besides personal skills, such as teamwork, guiding discussions and representing work results will be acquired through the workshop based structure of the event under its own planning and management.</p>
Literature	<ul style="list-style-type: none"> • Andreassen, M.M., Design for Assembly, Berlin, Springer 1985. • Ashby, M. F.: Materials Selection in Mechanical Design, München, Spektrum 2007. • Beckmann, H.: Supply Chain Management, Berlin, Springer 2004. • Hartmann, M., Rieger, M., Funk, R., Rath, U.: Zielgerichtet moderieren. Ein Handbuch für Führungskräfte, Berater und Trainer, Weinheim, Beltz 2007. • Pahl, G., Beitz, W.: Konstruktionslehre, Berlin, Springer 2006. • Roth, K.H.: Konstruieren mit Konstruktionskatalogen, Band 1-3, Berlin, Springer 2000. • Simpson, T.W., Siddique, Z., Jiao, R.J.: Product Platform and Product Family Design. Methods and Applications, New York, Springer 2013.

Course L1255: Integrated Product Development II	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1155: Aircraft Cabin Systems				
Courses				
Title	Typ		Hrs/wk	CP
Aircraft Cabin Systems (L1545)	Lecture		3	4
Aircraft Cabin Systems (L1546)	Recitation Section (large)		1	2
Module Responsible	Prof. Ralf God			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge in: <ul style="list-style-type: none"> • Mathematics • Mechanics • Thermodynamics • Electrical Engineering • Control Systems 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>	Students are able to: <ul style="list-style-type: none"> • describe cabin operations, equipment in the cabin and cabin Systems • explain the functional and non-functional requirements for cabin Systems • elucidate the necessity of cabin operating systems and emergency Systems • assess the challenges human factors integration in a cabin environment Students are able to: <ul style="list-style-type: none"> • design a cabin layout for a given business model of an Airline • design cabin systems for safe operations • design emergency systems for safe man-machine interaction • solve comfort needs and entertainment requirements in the cabin Students are able to: <ul style="list-style-type: none"> • understand existing system solutions and discuss their ideas with experts Students are able to: <ul style="list-style-type: none"> • Reflect the contents of lectures and expert presentations self-dependent 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	120 Minutes			
Assignment for the Following Curricula	Electrical Engineering: Specialisation Control and Power Systems Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory International Management and Engineering: Specialisation II. Aviation Systems: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Aircraft Systems Engineering: Elective Compulsory			

Course L1545: Aircraft Cabin Systems	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	<p>The objective of the lecture with the corresponding exercise is the acquisition of knowledge about aircraft cabin systems and cabin operations. A basic understanding of technological and systems engineering effort to maintain an artificial but comfortable and safe travel and working environment at cruising altitude is to be achieved.</p> <p>The course provides a comprehensive overview of current technology and cabin systems in modern passenger aircraft. The Fulfillment of requirements for the cabin as the central system of work are covered on the basis of the topics comfort, ergonomics, human factors, operational processes, maintenance and energy supply:</p> <ul style="list-style-type: none"> • Materials used in the cabin • Ergonomics and human factors • Cabin interior and non-electrical systems • Cabin electrical systems and lights • Cabin electronics, communication-, information- and IFE-systems • Cabin and passenger process chains • RFID Aircraft Parts Marking • Energy sources and energy conversion
Literature	<ul style="list-style-type: none"> - Skript zur Vorlesung - Jenkinson, L.R., Simpkin, P., Rhodes, D.: Civil Jet Aircraft Design. London: Arnold, 1999 - Rossow, C.-C., Wolf, K., Horst, P. (Hrsg.): Handbuch der Luftfahrzeugtechnik. Carl Hanser Verlag, 2014 - Moir, I., Seabridge, A.: Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Wiley 2008 - Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGraw-Hill, 2003 - Kompendium der Flugmedizin. Verbesserte und ergänzte Neuauflage, Nachdruck April 2006. Fürstenfeldbruck, 2006 - Campbell, F.C.: Manufacturing Technology for Aerospace Structural Materials. Elsevier Ltd., 2006

Course L1546: Aircraft Cabin Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf God
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module Manual M.Sc. "Product Development, Materials and Production"

Module M1025: Fluidics				
Courses				
Title	Typ		Hrs/wk	CP
Fluidics (L1256)	Lecture		2	3
Fluidics (L1371)	Project/problem-based Learning		1	2
Fluidics (L1257)	Recitation Section (large)		1	1
Module Responsible	Prof. Dieter Krause			
Admission Requirements	None			
Recommended Previous Knowledge	Good knowledge of mechanics (stereo statics, elastostatics, hydrostatics, kinematics and kinetics), fluid mechanics, and engineering design			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	<p><i>Knowledge</i> After passing the module students are able to</p> <ul style="list-style-type: none"> explain structures and functionalities of hydrostatic, pneumatic, and hydrodynamic components, explain the interaction of hydraulic components in hydraulic systems, explain open and closed loop control of hydraulic systems, describe functioning and applications of hydrodynamic torque converters, brakes and clutches as well as centrifugal pumps and aggregates in plant technology <p><i>Skills</i> After passing the module students are able to</p> <ul style="list-style-type: none"> analyse and assess hydraulic and pneumatic components and systems, design and dimension hydraulic systems for mechanical applications, perform numerical simulations of hydraulic systems based on abstract problem definitions, select and adapt pump characteristic curves for hydraulic systems dimension hydrodynamic torque converters and brakes for mechanical aggregates. <p>Personal Competence</p> <p><i>Social Competence</i> After passing the module students are able to</p> <ul style="list-style-type: none"> discuss and present functional context in groups, organise teamwork autonomously. <p><i>Autonomy</i> After passing the module students are able to</p> <ul style="list-style-type: none"> obtain necessary knowledge for the simulation. 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	Compulsory	Bonus	Form	Description
	Yes	None	Attestation	Simulation hydrostatischer Systeme
Examination	Written exam			
Examination duration and scale	90			
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Mechatronics: Elective Compulsory International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1256: Fluidics	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	<p>Lecture</p> <p>Hydrostatics</p> <ul style="list-style-type: none"> • physical fundamentals • hydraulic fluids • hydrostatic machines • valves • components • hydrostatic transmissions • examples from industry <p>Pneumatics</p> <ul style="list-style-type: none"> • generation of compressed air • pneumatic motors • Examples of use <p>Hydrodynamics</p> <ul style="list-style-type: none"> • physical fundamentals • hydraulic continuous-flow machines • hydrodynamic transmissions • interoperation of motor and transmission <p>Exercise</p> <p>Hydrostatics</p> <ul style="list-style-type: none"> • reading and design of hydraulic diagrams • dimensioning of hydrostatic traction and working drives • performance calculation <p>Hydrodynamics</p> <ul style="list-style-type: none"> • calculation / dimensioning of hydrodynamic torque converters • calculation / dimensioning of centrifugal pumps • creating and reading of characteristic curves of pumps and systems <p>Field trip</p> <ul style="list-style-type: none"> • field trip to a regional company from the hydraulic industry. <p>Exercise</p> <p>Numerical simulation of hydrostatic systems</p> <ul style="list-style-type: none"> • getting to know a numerical simulation environment for hydraulic systems • transformation of a task into a simulation model • simulation of common components • variation of simulation parameters • using simulations for system dimensioning and optimisation • (partly) self-organised teamwork
Literature	<p>Bücher</p> <ul style="list-style-type: none"> • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 1: Hydraulik, Shaker Verlag, Aachen, 2011 • Murrenhoff, H.: Grundlagen der Fluidtechnik - Teil 2: Pneumatik, Shaker Verlag, Aachen, 2006 • Matthies, H.J. Renius, K.Th.: Einführung in die Ölhydraulik, Teubner Verlag, 2006 • Beitz, W., Grote, K.-H.: Dubbel - Taschenbuch für den Maschinenbau, Springer-Verlag, Berlin, aktuelle Auflage <p>Skript zur Vorlesung</p>

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1371: Fluidics	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1257: Fluidics	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Dieter Krause
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1183: Laser Systems and Methods of Manufacturing Design and Analysis				
Courses				
Title		Typ	Hrs/wk	CP
Laser Systems and Process Technologies (L1612)		Lecture	2	3
Methods for Analysing Production Processes (L0876)		Lecture	2	3
Module Responsible	Prof. Wolfgang Hintze			
Admission Requirements	None			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i> <i>Skills</i> Personal Competence <i>Social Competence</i> <i>Autonomy</i>				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	180 min			
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Product Development and Production: Elective Compulsory			

Course L1612: Laser Systems and Process Technologies	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Claus Emmelmann
Language	EN
Cycle	WiSe
Content	<ul style="list-style-type: none"> Fundamentals of laser technology Laser beam sources: CO₂-, Nd:YAG-, Fiber- and Diodelasers Laser system technology: beam forming, beam guidance systems, beam motion and beam control Laser-based manufacturing technologies: generation, marking, cutting, joining, surface treatment Quality assurance and economical aspects of laser material processing Markets and Applications of laser technology Student group exercises
Literature	<ul style="list-style-type: none"> Hügel, H. , T. Graf: Laser in der Fertigung : Strahlquellen, Systeme, Fertigungsverfahren, 3. Aufl., Vieweg + Teubner Wiesbaden 2014. Eichler, J., Eichler, H. J.: Laser: Bauformen, Strahlführung, Anwendungen, 7. Aufl., Springer-Verlag Berlin Heidelberg 2010. Steen W. M.; Mazumder J.: Laser material processing, 4th Edition, Springer-Verlag London 2010. J.C. Ion: Laser processing of engineering materials: principles, procedure and industrial applications, Elsevier Butterworth-Heinemann 2005. Gebhardt, A.: Understanding additive manufacturing, München [u.a.] Hanser 2011

Module Manual M.Sc. "Product Development, Materials and Production"

Course L0876: Methods for Analysing Production Processes	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hintze
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Modelling and simulation of machining and forming processes • Numerical simulation of forces, temperatures, deformation in machining • Analysis of vibration problems in machining (chatter, modal analysis,...) • Knowledge based process planning • Design of experiments • Machinability of nonmetallic materials • Analysis of interaction between machining process and machine tool systems with regard to process stability and quality • Simulation of machining processes by virtual reality methods
Literature	<p>Tönshoff, H.K.; Denkena, B.; Spanen Grundlagen, Springer (2004)</p> <p>Klocke, F.; König, W.; Fertigungsverfahren Umformen, Springer (2006)</p> <p>Weck, M.; Werkzeugmaschinen Fertigungssysteme 3, Springer (2001)</p> <p>Weck, M.; Werkzeugmaschinen Fertigungssysteme 5, Springer (2001)</p>

Module M1342: Polymers			
Courses			
Title	Typ	Hrs/wk	CP
Structure and Properties of Polymers (L0389)	Lecture	2	3
Processing and design with polymers (L1892)	Lecture	2	3
Module Responsible	Dr. Hans Wittich		
Admission Requirements	None		
Recommended Previous Knowledge	Basics: chemistry / physics / material science		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence <i>Knowledge</i>	Students can use the knowledge of plastics and define the necessary testing and analysis. They can explain the complex relationships structure-property relationship and the interactions of chemical structure of the polymers, including to explain neighboring contexts (e.g. sustainability, environmental protection).		
<i>Skills</i>	Students are capable of - using standardized calculation methods in a given context to mechanical properties (modulus, strength) to calculate and evaluate the different materials. - selecting appropriate solutions for mechanical recycling problems and sizing example stiffness, corrosion resistance.		
Personal Competence <i>Social Competence</i>	Students can - arrive at funded work results in heterogenius groups and document them. - provide appropriate feedback and handle feedback on their own performance constructively.		
<i>Autonomy</i>	Students are able to - assess their own strengths and weaknesses. - assess their own state of learning in specific terms and to define further work steps on this basis. - assess possible consequences of their professional activity.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	180 min		
Assignment for the Following Curricula	Materials Science: Specialisation Engineering Materials: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprotheses: Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		

Course L0389: Structure and Properties of Polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Hans Wittich
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> - Structure and properties of polymers - Structure of macromolecules Constitution, Configuration, Conformation, Bonds, Synthesis, Molecular weight distribution - Morphology amorph, crystalline, blends - Properties Elasticity, plasticity, viscoelasticity - Thermal properties - Electrical properties - Theoretical modelling - Applications
Literature	Ehrenstein: Polymer-Werkstoffe, Carl Hanser Verlag

Course L1892: Processing and design with polymers	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bodo Fiedler, Dr. Hans Wittich
Language	DE/EN
Cycle	WiSe
Content	<p>Manufacturing of Polymers: General Properties; Calendering; Extrusion; Injection Moulding; Thermoforming, Foaming; Joining</p> <p>Designing with Polymers: Materials Selection; Structural Design; Dimensioning</p>
Literature	<p>Osswald, Menges: Materials Science of Polymers for Engineers, Hanser Verlag</p> <p>Crawford: Plastics engineering, Pergamon Press</p> <p>Michaeli: Einführung in die Kunststoffverarbeitung, Hanser Verlag</p> <p>Konstruieren mit Kunststoffen, Gunter Erhard, Hanser Verlag</p>

Module M1185: Technical Complementary Course for PEPMS (according to Subject Specific Regulations)			
Courses			
Title	Typ	Hrs/wk	CP
Module Responsible	Prof. Dieter Krause		
Admission Requirements	None		
Recommended Previous Knowledge	See selected module according to FSPO		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	see selected module according to FSPO		
<i>Knowledge</i>			
<i>Skills</i>			
Personal Competence			
<i>Social Competence</i>			
<i>Autonomy</i>	see selected module according to FSPO		
Workload in Hours	Depends on choice of courses		
Credit points	6		
Assignment for the Following Curricula	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Elective Compulsory		

Module M1170: Phenomena and Methods in Materials Science			
Courses			
Title	Typ	Hrs/wk	CP
Experimental Methods for the Characterization of Materials (L1580)	Lecture	2	3
Phase equilibria and transformations (L1579)	Lecture	2	3
Module Responsible	Prof. Jörg Weißmüller		
Admission Requirements	None		
Recommended Previous Knowledge	Basic knowledge in Materials Science, e.g. Werkstoffwissenschaft I/II		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
<i>Knowledge</i>	The students will be able to explain the properties of advanced materials along with their applications in technology, in particular metallic, ceramic, polymeric, semiconductor, modern composite materials (biomaterials) and nanomaterials.		
<i>Skills</i>	The students will be able to select material configurations according to the technical needs and, if necessary, to design new materials considering architectural principles from the micro- to the macroscale. The students will also gain an overview on modern materials science, which enables them to select optimum materials combinations depending on the technical applications.		
Personal Competence			
<i>Social Competence</i>	The students are able to present solutions to specialists and to develop ideas further.		
<i>Autonomy</i>	The students are able to ... <ul style="list-style-type: none"> • assess their own strengths and weaknesses. • gather new necessary expertise by their own. 		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written exam		
Examination duration and scale	90 min		
Assignment for the Following Curricula	International Management and Engineering: Specialisation II. Product Development and Production: Elective Compulsory Materials Science: Core Qualification: Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory Product Development, Materials and Production: Specialisation Materials: Compulsory Theoretical Mechanical Engineering: Specialisation Materials Science: Elective Compulsory		

Course L1580: Experimental Methods for the Characterization of Materials	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Jürgen Markmann, Prof. Patrick Huber
Language	DE
Cycle	WiSe
Content	<ul style="list-style-type: none"> • Structural characterization by photons, neutrons and electrons (in particular X-ray and neutron scattering, electron microscopy, tomography) • Mechanical and thermodynamical characterization methods (indenter measurements, mechanical compression and tension tests, specific heat measurements) • Characterization of optical, electrical and magnetic properties (spectroscopy, electrical conductivity and magnetometry)
Literature	William D. Callister und David G. Rethwisch, Materialwissenschaften und Werkstofftechnik, Wiley&Sons, Asia (2011). William D. Callister, Materials Science and Technology, Wiley& Sons, Inc. (2007).

Module Manual M.Sc. "Product Development, Materials and Production"

Course L1579: Phase equilibria and transformations	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Jörg Weißmüller
Language	DE
Cycle	WiSe
Content	Fundamentals of statistical physics, formal structure of phenomenological thermodynamics, simple atomistic models and free-energy functions of solid solutions and compounds. Corrections due to nonlocal interaction (elasticity, gradient terms). Phase equilibria and alloy phase diagrams as consequence thereof. Simple atomistic considerations for interaction energies in metallic solid solutions. Diffusion in real systems. Kinetics of phase transformations for real-life boundary conditions. Partitioning, stability and morphology at solidification fronts. Order of phase transformations; glass transition. Phase transitions in nano- and microscale systems.
Literature	<p>D.A. Porter, K.E. Easterling, "Phase transformations in metals and alloys", New York, CRC Press, Taylor & Francis, 2009, 3. Auflage</p> <p>Peter Haasen, „Physikalische Metallkunde“ , Springer 1994</p> <p>Herbert B. Callen, "Thermodynamics and an introduction to thermostatistics", New York, NY: Wiley, 1985, 2. Auflage.</p> <p>Robert W. Cahn und Peter Haasen, "Physical Metallurgy", Elsevier 1996</p> <p>H. Ibach, "Physics of Surfaces and Interfaces" 2006, Berlin: Springer.</p>

Thesis

Module M-002: Master Thesis				
Courses				
Title	Typ	Hrs/wk	CP	
Module Responsible	Professoren der TUHH			
Admission Requirements	<ul style="list-style-type: none"> According to General Regulations §21 (1): <p>At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions.</p>			
Recommended Previous Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence <i>Knowledge</i>	<ul style="list-style-type: none"> The students can use specialized knowledge (facts, theories, and methods) of their subject competently on specialized issues. The students can explain in depth the relevant approaches and terminologies in one or more areas of their subject, describing current developments and taking up a critical position on them. The students can place a research task in their subject area in its context and describe and critically assess the state of research. 			
<i>Skills</i>	<p>The students are able:</p> <ul style="list-style-type: none"> To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question. To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/or incompletely defined problems in a solution-oriented way. To develop new scientific findings in their subject area and subject them to a critical assessment. 			
Personal Competence <i>Social Competence</i>	<p>Students can</p> <ul style="list-style-type: none"> Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structured way. Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addressees while upholding their own assessments and viewpoints convincingly. 			
<i>Autonomy</i>	<p>Students are able:</p> <ul style="list-style-type: none"> To structure a project of their own in work packages and to work them off accordingly. To work their way in depth into a largely unknown subject and to access the information required for them to do so. To apply the techniques of scientific work comprehensively in research of their own. 			
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0			
Credit points	30			
Course achievement	None			
Examination	Thesis			
Examination duration and scale	According to General Regulations			
Assignment for the Following Curricula	Civil Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Chemical and Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Energy and Environmental Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Global Innovation Management: Thesis: Compulsory Computational Science and Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory Interdisciplinary Mathematics: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Materials Science: Thesis: Compulsory Mechanical Engineering and Management: Thesis: Compulsory Mechatronics: Thesis: Compulsory Biomedical Engineering: Thesis: Compulsory Microelectronics and Microsystems: Thesis: Compulsory Product Development, Materials and Production: Thesis: Compulsory Renewable Energies: Thesis: Compulsory			

Module Manual M.Sc. "Product Development, Materials and Production"

	Naval Architecture and Ocean Engineering: Thesis: Compulsory Ship and Offshore Technology: Thesis: Compulsory Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory Theoretical Mechanical Engineering: Thesis: Compulsory Process Engineering: Thesis: Compulsory Water and Environmental Engineering: Thesis: Compulsory Certification in Engineering & Advisory in Aviation: Thesis: Compulsory
--	--